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ABSTRACT

This book is designed to provide elementary and middle school teachers with motivating problem-solving activities to use with their students. The text contains interesting and challenging problems from mathematics, language arts, social studies, and natural science which are divided into sections of activities of short, middle, and longer duration and those requiring some computer hardware and software. Also included are chapters on problem-solving strategies and techniques and on the parents' role in encouraging their children. Appendices contain activity answer keys, additional problem-solving supplies, selected problem-solving software, and additional readings. (MKR)

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Problem Solving ACROSS THE Curriculum

* * *

Improving Students' Problem-Solving Skills
Using Off-Computer & On-Computer Activities

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ISTE Publications

John F. Beaver

About the Author

John F. Beaver is an Associate Professor of Education who is in his seventh year at the State University of New York in Buffalo. He teaches graduate educational technology courses for teachers and administrators as well as undergraduate courses in methods of teaching mathematics, science, and social studies. He also coordinates two computer labs (one IBM and one Macintosh) operated for education majors and faculty.

Before completing his doctorate at Michigan State University, he was a teacher for fifteen years in international settings including Australia, Malaysia, The Netherlands, and Egypt. During these years, he developed, field-tested, and refined the problem-solving activities contained in this text.

Dr. Beaver is the author of two texts (*Microsoft Works for Educators on the IBM PC* and *Compatibles* and *Microsoft Works for Educators on the Macintosh*) and numerous articles on problem solving and the instructional applications of technology. He is a frequent presenter at international, national, and regional educational conferences and consults nationally with school districts and organizations to help educators improve their students' critical-thinking and problem-solving skills. He also consults frequently with school districts to assist teachers and administrators in enhancing their professional productivity and instructional effectiveness through appropriate technology use.

Project Coordinator
Jean Hall
Editing
Bob Barber
Production
Corinne Tan
Book Design
Jean Hall and Corinne Tan
Book Cover
Corinne Tan

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Problem Solving Across the Curriculum

Improving Students' Problem-Solving Skills Using Off-Computer & On-Computer Activities

John F. Beaver

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From the Publisher

The International Society for Technology in Education (ISTE) strives to promote appropriate uses of technology to support and improve learning, teaching, and administration. As part of that mission, ISTE's goal is to provide individuals and organizations with high-quality and timely information, materials, and services that support technology in education.

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Jean Hall, Books and Courseware Manager
Ph. 503/346-0661; Internet: HallJea@oregon.uoregon.edu

Anita Best, Editor
Ph. 503/346-2400; Internet: Anita_Best@ccmail.uoregon.edu

International Society for Technology in Education
1787 Agate St.
Eugene, OR 97403-1923

About This Book

The purchaser of *Problem Solving Across the Curriculum* receives this book and a single-user site license. The public domain software is *not* included and *is* necessary to complete the On-Computer Activities included in this book.

The single-user site license gives the one person who is designated as the "primary user" of the package the right to make copies of worksheets and other material necessary for use in his or her classroom; this right does not transfer to class participants or other teachers. If the single-user site license is purchased by a school or school district, the intent is that one person be designated as the primary user. If several teachers will use the book, a separate package must be purchased for each teacher.

Those who are interested in purchasing an Apple II series disk of the public domain software referred to in this book may contact ISTE's Ordering Department at 1/800/336-5191.

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First, I want to thank my father, Fred C. Beaver, for encouraging and supporting my involvement in problem-solving and critical-thinking activities. His contribution to my intellectual development has been enormous. To this day, he remains my model of what an ideal father should be. Thanks, Dad!

My fascination with problem solving was greatly enhanced during my fifteen years of teaching elementary- and middle-school students. During those years, I decided problem solving was not simply a mathematics skill, but a real-world skill that was appropriate for all disciplines. I want to thank all of those students for the insights they gave me into their cognitive processes.

I also want to thank my editor, Dr. Nancy Deal, for her efforts on this text. The suggestions that she provided helped me improve the clarity of many of the text's activities. Finally, I would like to thank Anita Best for her encouragement and assistance in bringing the text to print.

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Section 1

Overview

Preface

This text is specifically designed to provide elementary and middle school teachers with motivating problem-solving activities to use with their students. The author's major premise is that students (and teachers) become better problem solvers by solving problems. The more problems you solve (in number and variety) the more competent you become as a problem solver. This text is filled with interesting and challenging problems from mathematics, language arts, social studies, and natural science. The activities permit students to practice a variety of problem-solving strategies and have fun at the same time.

How to Use This Book

The text is divided into sections: short duration activities, middle duration activities, longer duration activities, and activities requiring some computer hardware and software. My intent in structuring the text this way is to provide teachers with activities that are appropriate for use throughout the school day in a variety of disciplines. The short duration activities are designed as a change-of-pace experience to re-focus students' attention or fill transition periods from one task or subject to another. The middle duration activities will probably last ten or fifteen minutes (or longer) and provide students with a more in-depth problem-solving experience. The longer duration activities might fill an entire class period or serve to extend problem solving beyond the school day—overnight, over a weekend, or even over a school vacation. The on-computer activities provide suggestions for problem-solving experiences that take advantage of the motivational powers of technology.

Activities

Most of the activities can be used exactly as they appear in the text. For some of the activities (e.g. *Business Disorder*, *Sporting Sorting*, *Geometric Decoder*, *Digital Discoveries*, *Who Are the Basketball Champs?*, *Death-Star Rock Group*, and *Find My Number*), you will want to photocopy them and distribute copies to each of your students to reflect on individually—either during class time or at home. For many other activities (e.g. *Sock Confusions*, *Puzzlers*, *Mystery Numbers*, *Mini-Word Chains*, *Analogies*, *Depictions*, *Delusions*, *Hink Pinks*, *Complete the Pattern*, *Moving Matches*, *Riddles*, and *Guess My Number*), you can photocopy and then make a transparency to share with the whole class using an overhead projector. Still other activities (e.g. *Can You Explain This?*, *Twenty (or so) Questions*, *Boomerang*, *The Narrow Bridge*, *Game of NIM*, *Tangrams*, *Cuisenaire Builders*, and most of the On-Computer Activities) are best presented by the teacher (using appropriate support materials as the text explains) after reading the text's description of the activity.

However, there isn't any "right way" to use the materials contained in this text. The more experienced you are as a teacher and a problem solver, the more you will want to modify the activities to suit your own instructional style. If you are less familiar with problem solving or fairly new to the teaching profession, you may want to use the activities as they are explained in the text and then judge if you want to modify them the next time you employ them.

The text contains a wealth of fun but challenging activities to motivate and challenge your students. I hope that you and your students enjoy them.

Introduction

During the past decade, many leading educators have been calling for teachers to place more emphasis on higher-order thinking skills and problem-solving abilities. Despite these recommendations, a large number of students still receive insufficient assistance in developing their competence as problem solvers. In part, this is due to the difficult nature of teaching problem solving and other higher-order thinking skills. In addition, most teachers had little experience with problem solving during their own schooling and, possibly, during their teacher preparation programs. Another inhibiting factor is the lack of engaging, age-appropriate material designed to help teachers improve their students' problem-solving skills. This text is written to provide a wealth of fun but challenging activities that will encourage your students' efforts at becoming confident and competent problem solvers.

Some of the activities relate to mathematical orientation, while others relate to language arts, social studies, and natural science. These "across the curriculum" activities help students come to see problem solving as an important skill to use in all disciplines. Since most of the problem-solving experience students currently receive takes place in math classes, they generally come to see problem solving as part of the mathematics curriculum, just as basketball is part of the physical education curriculum. The activities in this text shift the focus from mathematics to all disciplines.

Some of the suggestions are designed to take advantage of the powers offered by a computer, but most activities require no special equipment or materials. Even the on-computer activities are written to emphasize the instructional process (what to do prior to computer use, on-computer recommendations, and post-computer follow-up ideas) rather than the technology.

An Apple II disk filled with public domain programs is available from ISTE that can be freely shared with your students and colleagues. See the About This Book page at the front of the book. At a time when many schools are replacing their established base of Apple computers with Macintoshes or IBM compatibles, these activities and the disk suggest instructional practices whereby powerful learning experiences can be gained from "obsolete" equipment. Throughout, the emphasis is on ideas and instruction, not on technology.

The majority of the activities described in the text do not require the use of a computer or special equipment. Some of these activities are called Off-Computer—Short Duration; they are designed as a few minutes' change-of-pace or motivation boost. Other activities are called Off-Computer—Middle Duration; they are designed for fifteen minutes to a full class period. Finally, some activities are called Off-Computer—Longer Duration; they are designed for extending problem solving outside the school day for evening or weekend homework. An answer key with guided solutions (for all activities that have answers) is provided to permit teachers or students to work backward from the solution and improve their understanding of the problem.

Do you ever have to engage in problem solving? Probably many, many times every day! Every time we are confronted by some situation where there is some obstacle between us and what we would like to have or do, we are facing a situation requiring some type of problem-solving response. The problems can be small ones, like "Where did I leave the book I was reading?" or vast, like "How can we overcome the drug problem in this country?" Sometimes we invent problems to engage us, in the form of card games, board games, puzzles, and athletic events. Frequently, life presents us with a variety of problems like "How do I get into my car without the key that I just locked inside it?" In short, problem solving is an important part of our everyday life.

By the way, we have been discussing this thing called "problem solving" for some time now, without defining it. **Just what is problem solving, anyway?**

Problem Solving is what you do when you are in a situation where you simply don't know what to do and you care enough not to just give up!

For our students to have successful lives in a future that will be filled with change, we must help them develop confidence in their problem-solving competence. The activities included in this text are designed to help students take an active interest in problem solving. Once students have an ownership interest in problem solving, improving their problem-solving skills is much easier.

A Problem-Solving Process

Successful problem solvers generally use a specific approach regardless of the type of problem they are confronting. If we want our students to become competent problem solvers, we must help them adopt a systematic approach. The exact steps they follow in the process are less important than the fact that the procedure is systematic and comfortable for them. Here is one standard procedure:

1. Identify and clarify the problem situation.
2. Draw on your past problem-solving experiences.
3. Select a likely problem-solving strategy to try.
4. Implement the problem-solving strategy.
5. Repeat the cycle if necessary (do not expect the process will always work).

Problem-Solving and the Affective Domain

Developing competence as a problem solver involves more than simply mastering a series of skills. Several considerations in the affective domain are equally important for successful problem solvers. The following list includes attitudes that individuals attempting to become competent problem solvers should identify and incorporate into their problem-solving efforts.

- The problem solver must feel some ownership for (i.e. interest in) the problem.
- The problem solver must desire a solution to the problem.
- The problem solver must feel capable of solving the problem.
- The problem solver must be willing to begin the problem-solving process.
- The problem solver must be willing to risk possible failures and repeated attempts to solve a problem.

Section 2

Problem-Solving Strategies and Techniques

Chapter 1.
Problem-Solving Strategies

Problem-solving strategies serve a purpose similar to that of a carpenter's toolbox. The more tools the carpenter has available (and is competent with), the more likely it is that he/she will be able to perform a given task efficiently. The more problem-solving strategies a student understands and can apply, the more problem situations he/she will be able to resolve successfully. The following list includes some of the problem-solving strategies that our students should have available in their problem-solving "toolboxes." The list also gives some characteristics as well as positive and negative features of the strategies.

- **Trial and Error or Exhaustive Search.**
  (Find a needle in a haystack)

  This strategy tends to be very inefficient.

  It works best if applied systematically.

  The process improves with careful record keeping.

  It can help by providing solutions to future problems.

  Sometimes it is the only possible approach.

- **Successive Approximations.**
  (Find the number I've chosen between 1 and 100)

  This strategy involves a systematic narrowing of a range.

  The technique is applicable only with sequential data.

  It involves repeated applications of a process.

  It can also suggest solutions to future problems.

- **Look for a Pattern.**
  (What is the next number: 1, 4, 9, 16, ...)

  This strategy requires significant problem-solving ability.

It is best for students to find patterns, not be given them.

It is best for students to discover rules, not be given them.

It is most useful if a rule can be applied, not memorized.

The difficulty with this strategy lies in deciding which rule or pattern to apply.

- **Make a Chart or Table.**
  (Identify the correct outcome from many clues)

  This strategy is a excellent for organizing data.

  It can make complex problem situations less abstract.

  It is useful for depicting relationships in data.

  It can be very effective for visual learners.

- **Draw a Picture.**
  (Locate an object hidden in a room)

  This strategy is excellent for displaying data.

  It can make complex problem situations less abstract.

  It can be very effective for visual learners.

- **Make a Map.**
  (Find buried treasure hidden on an island)

  This strategy is excellent for depicting directional data.

  It can make seemingly unrelated data less confusing.

  It can make complex problem situations less abstract.

  It can be very effective for visual learners.

- **Make a Model.**
  (Name the digit on a die which is opposite from 4)

  This strategy is excellent for 3-dimensional problems.

  It is an excellent technique for rotational problems.

  It can make complex geometrical problems less abstract.

  It is very effective for visual learners.

- **Work Backwards.**
  (Interpret an event from historical precedents)

  This strategy is excellent for training students to interpret historical events or predict plot developments.

  It helps students gain an understanding of processes instead of products.

  It helps establish linkages between diverse elements.

  It illustrates the bi-directional nature of many problems.

  It is the ideal technique for problems in which the final state is known.

- **Solve a Simpler Version of the Problem.**
  (What is $5\frac{7}{16} \div 2\frac{5}{8}$*; first try* $\frac{1}{2} \div \frac{1}{4}$*)*

  This strategy is ideal for solving procedure problems.

  It can make complex problems less confusing.

  It is the perfect technique in problems where the process is the key ingredient.

- **Use Cooperative Effort and Diversify.**
  (Produce a class newsletter as a team)

  This strategy requires team effort and cooperation.

  It is a critical real-life survival strategy.

  It is quite effective in problem situations that can be modularized.

  It is most powerful when roles are adopted by the team.

  It is especially useful when combined with a top-down approach to problem situations (an approach where a complex problem is broken down into smaller component parts that can each be solved separately).

- **Use Divergent or Lateral Thinking.**
  (Drop a fresh egg three feet over a cement floor without breaking it)

  This strategy requires the problem solver to stand back and reexamine the problem situation.

It asks the problem solver to consider the entire problem situation, including any preconceptions he/she may be bringing to the problem.

It expects the problem solver to engage in lateral, instead of linear, thinking processes.

It can be especially effective in unusual, non-traditional problem situations.

Chapter 2.
Practicing Problem-Solving Strategies

Students develop and refine problem-solving strategies most successfully if they are provided opportunities to practice their skills throughout the school day—and beyond. In particular, students should have occasions to practice their problem-solving strategies in every discipline—not just in mathematics class. The following list includes suggestions for activities from varied content areas.

- **Trial and Error or Exhaustive Search.**

  Find a lost (or misplaced) object.

  Locate a river on a map without the use of an index.

  Find a character's first lines in a play.

  Identify substances that will have a specific chemical reaction when they are combined.

- **Successive Approximations.**

  Create a computer program with a binary search routine.

  Find an encyclopedia article, given a title reference.

  Locate historical events on a timeline.

  Identify a certain number between 1 and 1,000 when responses of "Higher" and "Lower" are given to guide the search.

- **Look for a Pattern.**

  Identify word origins from word parts.

  Interpret history using recurrent historical events.

  Use previous experiments to predict possible results.

  Use musical scores to explain movements in a symphony.

Anticipate action based on an identified literary convention.

- **Make a Chart or Table.**

  Make a chart illustrating the relationshipamong several characters in a novel.

  Make a table listing historical events and the societal changes they produced.

  Create a chart of the events in a character's life and their effect on his/her personality.

- **Draw a Picture.**

  Make an illustration of the furniture arrangement in a room described in a novel.

  Draw the protagonist in a novel so the picture depicts the individual's character.

  Illustrate the laboratory set-up to be used during a science experiment.

- **Make a Map.**

  Make a map of your bedroom.

  Make a map of your route from home to school.

  Make a map explaining the events of a Civil War battle.

  Make maps of the classroom using varied scales.

- **Make a Model.**

  Create a cube to use with the computer program, *Super Factory*.

  Make rectangular solids, to learn about the concept of surface area.

  Make a solid object, to understand volume.

  Make a three-dimensional model of one area of your town.

- **Work Backwards.**

  Explain plot twists in a novel based on previous actions.

Trace the development of a character's traits to their origin.

Trace the impact of the automobile on the configuration of American cities in the East versus cities in the West.

Describe the chemical ingredients of a substance based on observed reactions.

- **Solve a Simpler Version of the Problem.**

  To find the square root of 35,986—first find the square root of 100.

  To trace the development of character traits in a Dickens novel—first trace the development of character traits in a Judy Bloom book.

  To identify which three chemicals are being stored in the same container by their unique properties—first identify one chemical by its unique properties.

  To determine the identities of each animal from traces left by three different animals occupying the same biome—first identify one animal from the traces it leaves in a biome.

- **Use Cooperative Effort and Diversify.**

  Report a news story as a team.

  Design and code a modular computer program so that each component of it functions independently.

  Conduct a school election campaign.

  Publish a school newspaper.

  Create a school yearbook.

- **Use Divergent or Lateral Thinking.**

  Use any strategy you wish to ensure that a fragile object does not break when dropped from a third floor school window to the asphalt playground.

  Create alternate endings for novels such as *Charlotte's Web* based on plot changes such as "What would have happened if the people had revered Charlotte instead of Wilbur when they read the messages in the webs?"

Speculate on what changes would have occurred if humankind had evolved from another species than the ape. For instance, if we had evolved from rodents, would we have created vast subterranean civilizations instead cities filled with skyscrapers?

Chapter 3.
Connecting Strategies and Activities

The following chart is provided as a quick reference tool for teachers wishing to provide their students with balanced problem-solving experiences affording practice using many different strategies. The table lists the various problem-solving strategies horizontally down the page. In the four columns to the right of each strategy are listed short duration, middle duration, long duration, and on-computer activities that should provide students with practice using that particular strategy.

In some cases, the same activities are listed next to several different strategies. It is important to point out that most activities can be solved by more than one particular problem-solving strategy. For example, nearly every problem can be eventually solved by some form of a trial and error approach. However, there is often one strategy that is best fitted to a particular problem activity. As students improve in their problem-solving competence, we should encourage them to look for more efficient problem-solving strategies.

Nevertheless, this chart is not provided as the definitive word on the "right way" to approach each problem's solution. Teachers should continue to encourage their students to examine and evaluate divergent approaches to solving problems. When this instructional technique is used, students develop a deeper understanding of problem-solving strategies than they will if they are told how to solve each problem. We don't want to label activities for students (e.g. "Here is a "successive approximation problem") the way mathematics texts group word problems with the operation they reinforce (e.g. addition word problems after the addition chapter and division word problems after the division chapter). Help your students explore and discover rather than memorize!

Correlation Chart

Strategy	Short Duration Activity	Middle Duration Activity	Longer Duration Activity	On-Computer Activity
Trial and Error	Hink Pinks Sock Confusions #1 & #2 Centennial Digits	Moving Matches Pyramid Inversion Diverse Mysteries I, II, & III Puzzlers #3 Digital Arrangements	Who Are the Basketball Champs? Geometric Decoder	*Muppetville* *King's Rules* *Word-A-Mation* *Re-sequencing Instructions* *Magic Square*
Successive Approximations	Find My Number What's My Number? #1 & #2 Sequential Digits Mystery Numbers #1	20 (or so) Questions Puzzlers #3	Digital Discovery I & II Find My Word I & II	*Bagels* *Hurkle Game* *King's Rule*
Draw a Picture	Grand Delusions	Connect the Dots	Cuisenaire Builders	
Make a Map				*Hurkle Game* *Mystery of the Hotel Victoria*

Strategy	Short Duration Activity	Middle Duration Activity	Longer Duration Activity	On-Computer Activity
Look for a Pattern	Geometric Relationships Analogies Word Chains Complete the Pattern Sock Confusions #1 & #2 Sequential Digits Jug Puzzlers #1 & #2 Guess My Rule	Can You Explain This? 20 (or so) Questions Pyramid Inversion Connect the Dots Diverse Mysteries I, II, & III The Narrow Bridge Puzzlers #3 Digit Dilemmas Digital Arrangements	Cuisenaire Builders The NIM Game Who Are the Basketball Champs? Tangrams Calendar Developers Geometric Decoder Digital Discovery I & II Find My Word I & II A Non-Vulcan Mind Meld	*Bagels* *Division* *Tower* *Muppetville* *Puzzle Tanks* *The Factory* *How the West Was 1+3x4* *King's Rules* *Word-A-Mation* *Animal Trackers* Re-sequencing Instructions Solar System, States, Holidays, & Presidents Multiplication Table Magic Square Calculating Sports Statistics Graphing the Weather

Strategy	Short Duration Activity	Middle Duration Activity	Longer Duration Activity	On-Computer Activity
Make a Chart	Find My Number What's My Number? #1 & #2 Mystery Numbers #1	Hi School Dilemma	Who Are the Basketball Champs? Death-Star Rock Group Business Disorder Sporting Sorting Digital Discovery I & II Cooperative Chaos	Division *Muppetville* *Mystery of the Hotel Victoria*
Create a Model	Jug Puzzlers #1 & #2	Moving Matches	The NIM Game Tangrams	*The Factory*
Work Backwards	Complete the Pattern Centennial Digits The Amoebae Jar Guess My Rule	Pyramid Inversiom Keep Your Balance I & II Diverse Mysteries I, II, & III The Narrow Bridge Puzzlers #3 Digital Arrangements	The NIM Game Who Are the Basketball Champs? Tangrams Calendar Developers Sporting Sorting	*Towers* *Puzzle Tanks* *The Factory* *Word-A-Mation* *The NIM Game*

Strategy	Short Duration Activity	Middle Duration Activity	Longer Duration Activity	On-Computer Activity
Solve a Simpler Version	Hink Pinks Complete the Pattern	Moving Matches Keep Your Balance I & II Puzzlers #3 Digital Arrangements	Cuisenaire Builders The NIM Game Calendar Developers	*Bagels* *King's Rules* *The NIM Game*
Use Cooperative Effort		20 (or so) Questions	Cuisenaire Builders Cooperative Chaos	Guiding Brainstorming Sessions Creating Collaborative Stories Conducting Class Surveys Interest & School-wide Surveys
Divergent or Lateral Thinking	Word Depictions I, II, III, IV, V, & VI Watch Your Assumptions Boomerang This Problem is Not a Yolk Riddles Grand Delusions	Can You Explain This? Moving Matches Connect the Dots	A Non-Vulcan Mind Meld	

Chapter 4.
Techniques For Successful Problem-Solving Activities

When you engage a classroom of students in problem-solving activities such as those included in this text, some students always "get it" far more quickly than others. If you allow the quickest to dictate the pace and "solve the problem" before the others have had sufficient time to understand and reflect on the nature of the problem situation, quite likely the less confident students will soon give up trying to improve their problem-solving competence. Conversely, if you never acknowledge the most accomplished problem solvers in some way, they may get discouraged or frustrated at always having to wait for the others. The following instructional techniques suggest ways you can structure the learning environment so that problem-solving activities result in a successful experience for all your students. When you present a problem situation, ask your students to follow these steps:

- **Reflect individually on the nature of the problem.**
  (What kind of a problem is this?)
- **Reflect individually on possible approaches for solving the problem.**
  (What strategy should I use to try to solve this problem?)
- **Discuss with a partner the approach(es) you plan to use for solving the problem.**
  (This is my plan for attacking the problem; what's your idea?)
- **Signal the teacher (raise hand, etc.) when you reach a potential solution to the problem.**
- **Reflect on alternative problem-solving approaches and solutions to the problem.**
- **Explain your potential solution to your partner.**
  (Here is the way I arrived at this solution; what do you think?)

- **Modify the original problem to create a similar (but different) new problem.**
- **Explain your potential solution to the class.**
  (Do we all understand that approach?)
- **Listen to different solutions and different approaches from other class members.**
  (Did anyone else get a different answer or use a different approach to get this solution?)
- **Share the modified problems with the class and use the same approach to solve them.**
  (Here's my new problem; can you solve it?)

Chapter 5.
Parents' Role: Encouraging Their Children

Parents have an enormous influence on their children's interests, attitudes, and self-concept. The manner in which parents respond to problem-solving activities can greatly affect their children's feelings about problem solving in general and their abilities to solve problems. Naturally, the same statement can be made about many other important educational issues, including learning to read, developing responsibility, and improving writing skills. However, this text focuses on improving problem-solving skills.

When I taught elementary and middle school students, I would use occasions such as Open House (or Parent Night) and Parent Conferences to explain my problem-solving activities to my students' parents. Often parents were uncomfortable with problem solving themselves and wanted an explanation of what I was doing in class and how they could help at home. I would explain my belief that the more their children engaged in problem-solving activities, the better problem solvers they would become. I would discuss several of the problem-solving activities we had engaged in and work through the solution process with them. In addition, I would share ways in which I felt that they could help their children become more competent problem solvers.

The series of **Encouragers** and **Discouragers** listed on the following pages suggest approaches that parents should seek to adopt (the **Encouragers**) or avoid (the **Discouragers**). Make a transparency of them to present to parents at your next Open House. However, for any of the suggestions to have value, parents must demonstrate *genuine* interest in their children's problem-solving activities.

Encouragers

These practices are designed to help parents encourage the development of their children's problem-solving skills. Parents should employ these approaches as frequently as possible.

- **Discuss problem-solving activities with your children.**

- **Show interest in your children's problem-solving activities.**
- **Encourage your children to formulate divergent answers to problem-solving situations and to explain their thinking processes to you.**
- **Ask your children if they engaged in any problem-solving activities that day and have them explain them.**
- **Ask your children to restate the problem situation in their own words.**
- **Ask your children to solve problem situations with different strategies whenever it is appropriate.**
- **Encourage your children to look for multiple answers to problem-solving activities when it is appropriate.**
- **Ask your children to develop a new problem-solving activity by modifying the one you and they have just solved.**
- **Try to solve your children's problem-solving activities independently and explain your problem-solving strategy to them. Also, ask them to share their thought processes with you.**
- **Use family opportunities, such as long drives and evenings, to discuss problem solving and engage in problem-solving activities (bring sample activities along in the car, etc.).**
- **Promote problem solving as a lifelong activity and advocate the importance of becoming a competent problem solver.**
- **Indicate to your children's teachers the value you place on problem solving and your strong support of problem-solving activities in and out of school.**

Discouragers

The following list contains approaches that parents should avoid using with their children. These practices can undermine the development of your child's self-confidence and problem-solving skills. Read these practices as though each was preceded by the word *Don't*.

- **Simply give your children "the answer" to a problem situation.**
- **Indicate to your children that you don't value problem solving by telling them that you're too busy, that you can't solve problems yourself, or that you weren't any good at problem solving when you were their age.**
- **Expect your children's approach to solving a problem to be the same as yours.**
- **Expect your children to be able to solve every problem they are given.**
- **Encourage your children to give up because the problem situation is difficult or confusing.**
- **Criticize your children's problem-solving efforts.**
- **Try to explain problem-solving strategies that aren't age-appropriate for your children (for example, explaining to a fourth-grade student an algebraic procedure such as the use of simultaneous equations).**
- **Embarrass your children about their problem-solving skills (or lack of them).**

Section 3

Off-Computer Problem-Solving Activities

Chapter 6.
Short-Duration Activities

Short duration activities serve a variety of purposes. They provide students with change-of-pace activities to help them stay focused and attentive. They all serve to keep students engaged in problem-solving experiences throughout the school day and across all curricular boundaries. You can use many of the on-going activities periodically throughout the school year. Other activities that you might only use one time can still trigger follow-on activities or ideas that either you or your students suggest.

The manner in which you use the activities will naturally influence the amount of time that they take in class. For the most part, the activities are designed to last a short time (1 to 5 minutes), often serving as a transition activity between content areas or topics. The activities may require a longer (or shorter) time periods depending on the ages, ability levels, and backgrounds of your students.

The activities (e.g. *Riddles*) may offer a humorous interlude that improves students' attitudes about a subject, school in general, or themselves. Some of the ideas (e.g. *Find My Pattern, Analogies,* and *Guess My Rule*) can be used as on-going activities that students come to enjoy and look forward to (or even ask for). Other activities (e.g. *Puzzlers* and *What's My Word*) challenge students to think about problem situations. There are also activities (e.g. *Mystery Numbers* and *Various Confusions*) that challenge students to experiment with numbers; activities (e.g. *Mini Word-Chains, Hink Pinks,* and *Depictions*) that ask students to play with language; and activities (e.g. *Delusions*) that challenge the manner in which students look at or think about certain topics.

Geometric Relationships Instructions

Use *Geometric Relationship* examples such as the ones listed on the following page as a way to introduce your students to the concept of analogies (or to broaden their understanding of relationships). These examples probably work best as a change-of-pace activity for your students. Either photocopy the page and distribute it to your students as an individual or small group worksheet, or make a transparency to share with the whole class using an overhead projector.

Ask your students first to determine the *best* answer to complete the relationship, then ask them to explain their response by indicating what relationship links the geometric shapes represented in the example. Challenge your students to create puzzles on their own that are similar to the one the class has just examined, and use these new examples as additional reinforcements for the whole class.

For each example, in the first question, you would ask students, "The shape over the letter A relates to the shape over the letter B in the same way that the shape over the letter C relates to the shape over which numbers from 1 to 5?" When a student answers "The shape over the number 5," ask the student to explain why that shape is the best answer for that example.

Geometric Relationships

1.

●	●	❑	○	●	■	◆	❑
A	B	C	1	2	3	4	5

Reason: ____

2.

○	◦	▲	▴	●	•	▫	▲
A	B	C	1	2	3	4	5

Reason: ____

3.

○	●	❑	○	●	■	◆	●
A	B	C	1	2	3	4	5

Reason: ____

4.

•	●	▪	○	■	●	◆	●
A	B	C	1	2	3	4	5

Reason: ____

5.

○	❑	●	○	●	■	◆	❑
A	B	C	1	2	3	4	5

Reason: ____

6.

◦	•	▫	◦	●	▪	❑	■
A	B	C	1	2	3	4	5

Reason: ____

7.

▴	❑	•	○	●	■	▲	❑
A	B	C	1	2	3	4	5

Reason: ____

Analogies Instructions

Use *Analogies* activities such as the ones listed on the following page to broaden your students' understanding of word relationships. These examples will probably work best as a change-of-pace activity for your students. Either photocopy the page and distribute it to your students as an individual or small group worksheet, or make a transparency to share with the whole class using an overhead projector.

For each analogy, first ask your students to determine the *best* word (or words) to complete the sense of the analogy. Next, ask them to explain why they believe that their suggestion is the best choice to complete the analogy. Finally, ask students to describe the relationship that connects the words in the analogy.

For each example, in the first analogy, you would ask students, "A compass is to direction as a thermometer is to what?" When a student answers "Temperature," ask the student to justify the answer and to explain why the relationship between a *compass* and *direction* is the same as the relationship between a *thermometer* and *temperature*.

In addition, challenge your students to create other analogies on their own that are similar to the one the class has just examined, and use them as additional reinforcements for the whole class.

Analogies

Compass is to direction as thermometer is to ____________
Reason: ____________

Likely is to improbable as miserly is to ____________
Reason: ____________

A day is to nighttime as a year is to ____________
Reason: ____________

Map is to driver as index is to ____________
Reason: ____________

Albany is to New York as Atlanta is to ____________
Reason: ____________

Quick is to slow as young is to ____________
Reason: ____________

New is to modern as old is to ____________
Reason: ____________

French is to France as ____________ is to Italy.
Reason: ____________

Too is to two as earn is to ____________
Reason: ____________

Hand is to glove as foot is to ____________
Reason: ____________

Ocean is to sea as ____________ is to stream.
Reason: ____________

No is to know as ____________ is to ____________
Reason: ____________

Football is to baseball as ____________ is to ____________
Reason: ____________

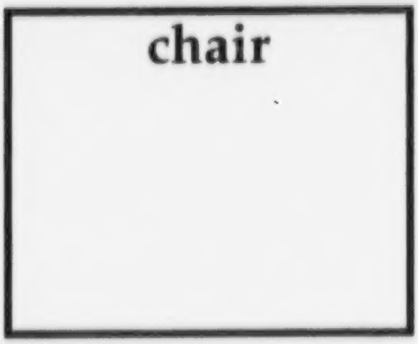
Teacher is to student as ____________ is to ____________
Reason: ____________

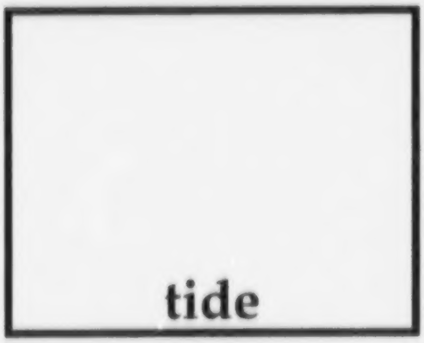
Word Depictions Instructions

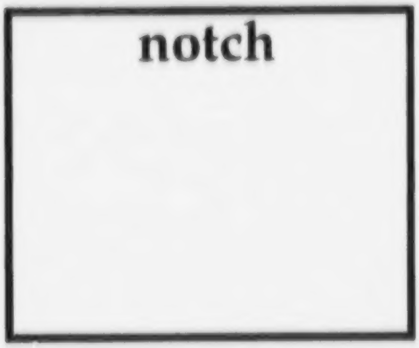
The next six pages contain examples of an activity that I call "Depictions," for lack of a better word. This is a fun, change-of-pace activity that you can use periodically throughout the school year. Each of the Depictions examples represent a word or phrase portrayed in some visual form. For example, "DAY YESTERDAY" represents the expression "day before yesterday" because of the arrangement of the words on the line (i.e. the word "day" comes before the word "yesterday" of the line).

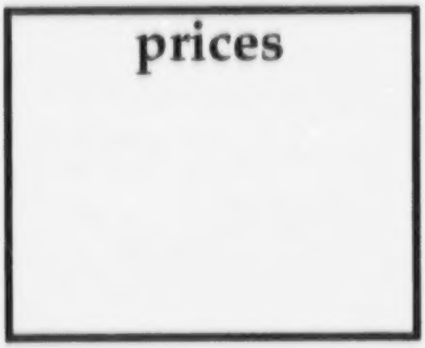
Photocopy the next six pages of Depiction examples and use them as worksheets to distribute to your class (one page at a time) for individual or group work. Alternatively, make a transparency from each of the six pages and present the examples to your class one at a time over a period of days or weeks (my preferred instructional approach). Challenge your students to create additional Depictions examples to use with their classmates at a later date.

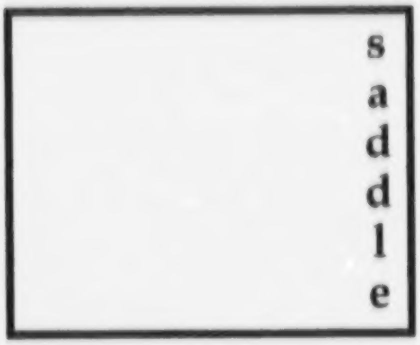
Word Depictions I

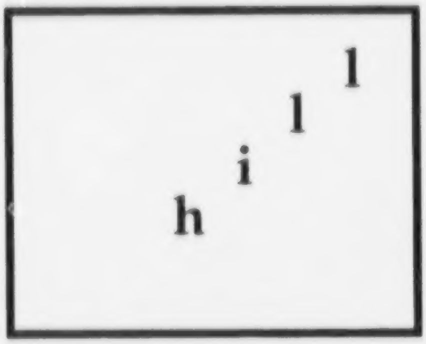




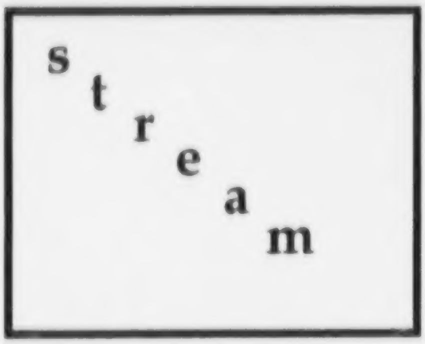


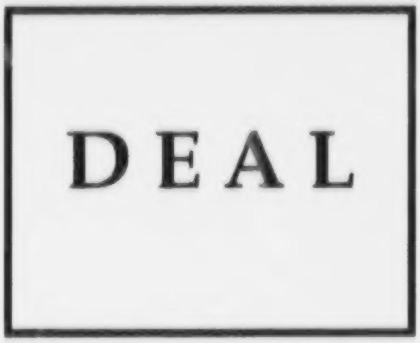


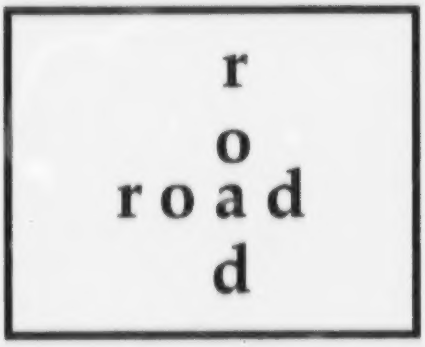


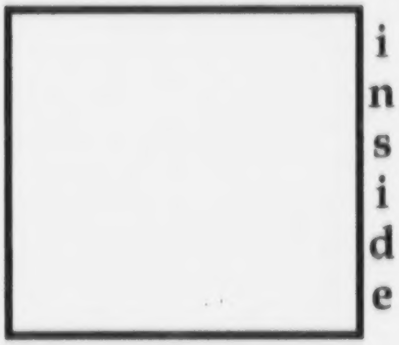


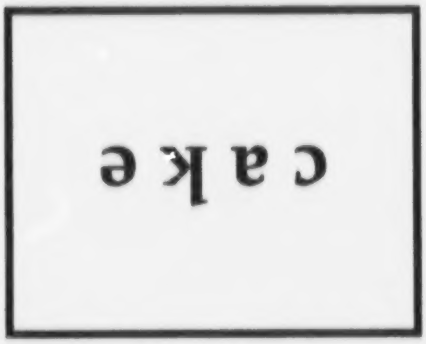
Word Depictions II

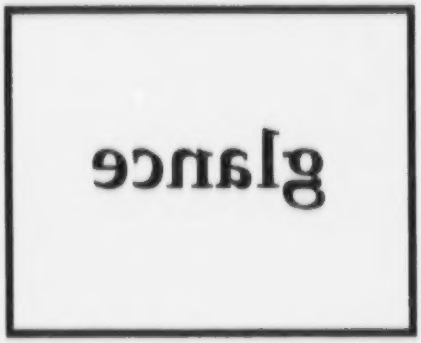




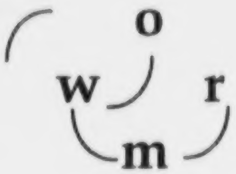








Word Depictions III



man
board

once
time

sleeping
job

wear
long

head
heels

Word Depictions IV

time time

age beauty

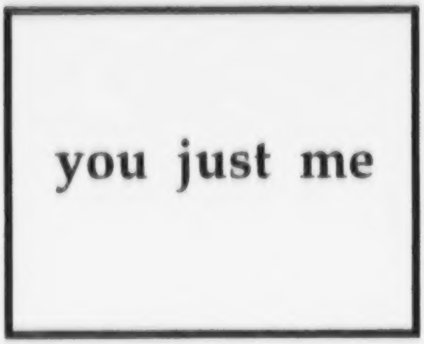
noon lazy

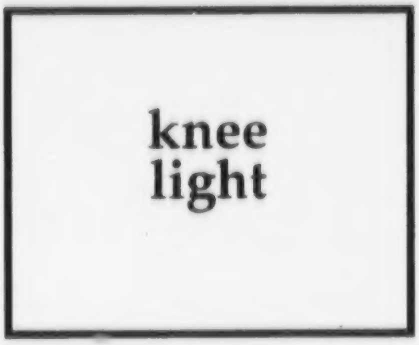
work pleasure

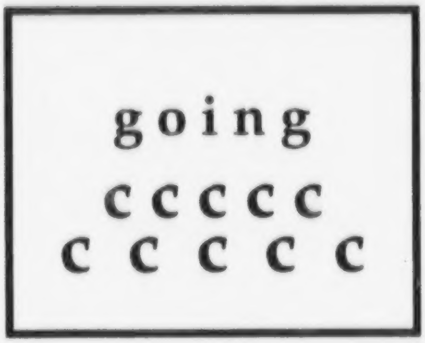
tomorrow day

day yesterday

Word Depictions V



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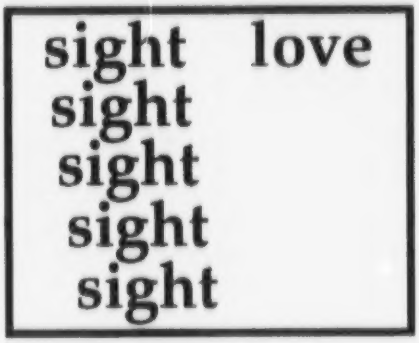
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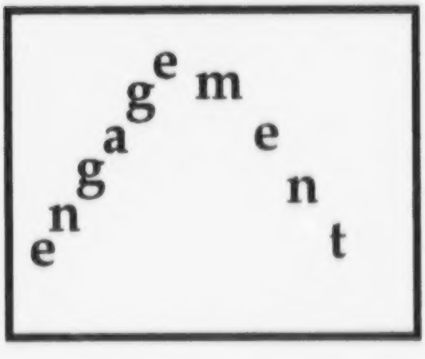
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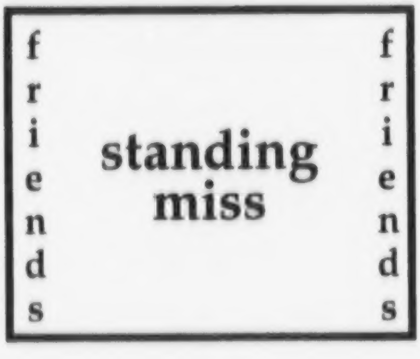
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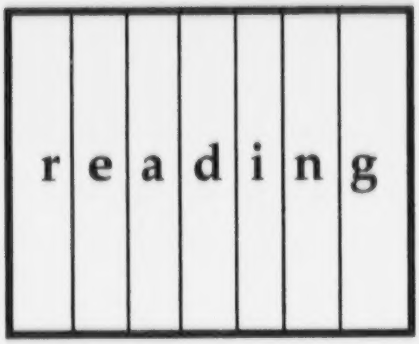
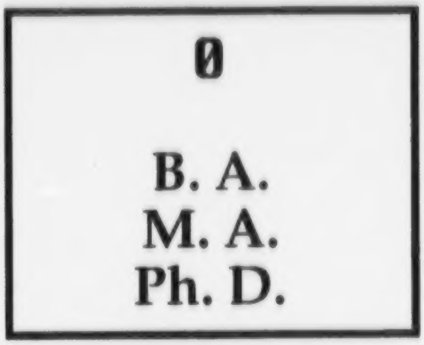
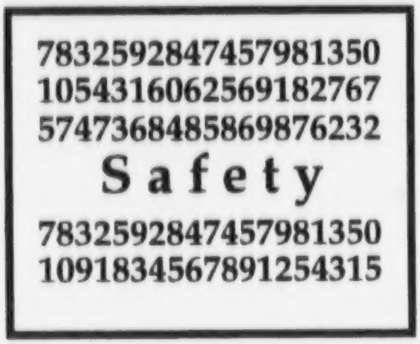
friends

Word Depictions VI



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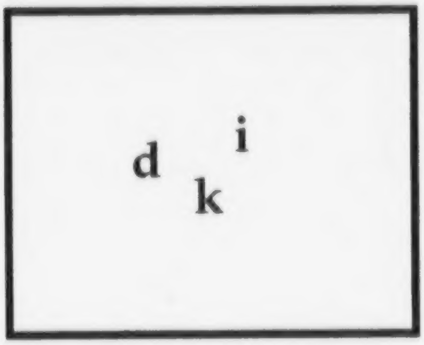

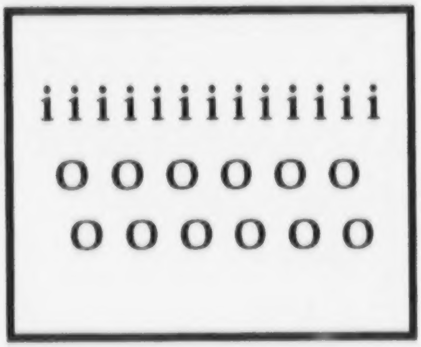
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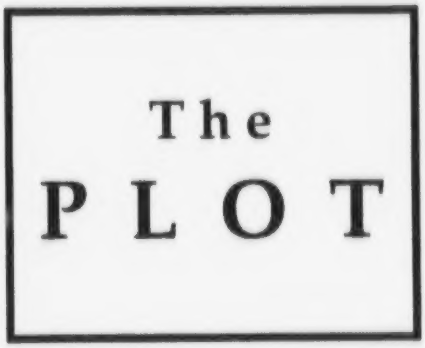


Mini-Word Chains Instructions

This is an on-going activity you can use periodically throughout the school year. Ask your students to find one word that will serve as the ending for the word in the first column and the beginning for the word in the second column. For example, if the first word was "shopping" and the second word was "wheel," the students are looking for a word that fits after "shopping" and before "wheel." One likely answer to this example is "cart" since it forms "shopping cart" and "cartwheel" with the two words given in the example.

Photocopy the next page and use it as a worksheet to distribute to your class, or make a transparency from it and present the examples to your class one at a time over a period of days or weeks. Using the blanks at the end of the page, challenge your students to create additional variations on this theme that will reinforce the concept for their classmates at a later date.

Mini-Word Chains

1. Stop __________ __________ __________ Dog
2. Skeleton __________ __________ __________ Hole
3. Butter __________ __________ __________ Paper
4. Hand __________ __________ __________ Pipe
5. Bird __________ __________ __________ Robe
6. Light __________ __________ __________ Boat
7. Note __________ __________ __________ Worm
8. Horse __________ __________ __________ Horn
9. Day __________ __________ __________ Loose
10. Buffalo __________ __________ __________ Collector

? __________ __________ ? __________

? __________ __________ ? __________

Find My Number Instructions

Choose a number between 1 and 100 without telling your class what it is. Challenge your class to discover which number you have chosen, by asking questions. When you first use the activity, limit the questions to ones that must be answered with only "yes" or "no." After each yes or no response, ask your class which numbers were eliminated from their search. Make a transparency (or copies for distribution to each student) of the following page and use it to keep track of eliminated numbers.

For example, imagine you selected the number 31 and told students to ask only questions that can be answered by "yes" or "no." One student might ask, "Is the number less than 50?" You would answer "Yes" and have students explain that all the numbers from 51 through 100 were eliminated. A second student could ask, "Is the number greater than 25?" You would answer "Yes" and have students state that numbers from 1 through 25 were eliminated. Continue the activity until the number is found.

Keep track of how many questions are needed to find each number and challenge students to discover the maximum number of guesses that should be required to find the number. If they are appropriate for your students' grade level, include requests like "Is this a prime number?" or "Does this number have 3 factors?" as well as the greater than and less than questions, After your class has used the activity for a while, you may want to open the questioning to responses other than simply "yes" and "no."

Find My Number

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

Hink Pinks Instructions

This is an on-going activity you can use periodically throughout the school year. For the Hink Pink questions, ask your students to find a pair of one-syllable rhyming words that are synonyms for the two words listed in each example. For the Hinky Pinky questions, ask your students to find the pair of two-syllable rhyming words that are synonyms for the two words listed in the example. For the Hinkity Pinkity questions, ask your students to find the pair of three-syllable rhyming words that are synonyms for the two words listed in the example. For the Hinkiditty Pinkiditty questions, ask your students to find the pair of four-syllable rhyming words that are synonyms for the two words listed in the example.

For example, if the Hink Pink clue words were "Indigo Sneaker," your students would be looking for two rhyming words (of one syllable) that are synonyms of "indigo" and "sneaker." One likely answer in this case is "Blue Shoe" since "indigo" is a shade of blue and "sneaker" is a type of shoe.

Photocopy the next page filled with examples and use it as a worksheet to distribute to your class, or make a transparency from it and present the examples to your class one at a time over a period of days or weeks. Use the blank examples to challenge your students to create additional samples to use with their classmates at a later date.

Hink Pinks

Hink Pinks

1. Crimson Toolhouse ____________ ____________
2. Reading Corner ____________ ____________
3. Class Edict ____________ ____________
4. Tidy Chair ____________ ____________
5. Washes Levis ____________ ____________
6. __________________ ____________ ____________

Hinky Pinkies

1. Pleasant Chap ____________ ____________
2. Scary Flashes ____________ ____________
3. Television Saga ____________ ____________
4. Urban Regret ____________ ____________
5. 1st day of School ____________ ____________
6. __________________ ____________ ____________

Hinkity Pinkities

1. Suspense Chronology ____________ ____________
2. Elk Melon ____________ ____________
3. Dr. Lechter ____________ ____________
4. __________________ ____________ ____________

Hinkiditty Pinkiditties

1. Dutchman's Winecellar ____________ ____________
2. ______________________ ____________ ____________

Complete the Pattern Instructions

Have your students determine the patterns in the series of numbers on the following page and then supply the missing numbers. Either photocopy the page and distribute it to your students as an individual or small group worksheet, or make a transparency to share with the whole class using an overhead projector. After your students have supplied the three numbers that complete the pattern, ask them to identify the number pattern—if it has a name. Next, have them state the algorithm that determines the next number in the series. Finally, challenge them to create new number patterns that extend the series they have completed or ones based on entirely different premises.

For example, let's say your students were given the following pattern: 3, 6, 9, 12, __, __, __. The first step is to complete the pattern by adding 15, 18, and 21. Next, we can identify the pattern as the "multiples of 3." The algorithm (or rule) that determines this pattern is "you add 3 to the current number to produce the next number." Finally, an extension of this particular pattern could well be a different set of multiples such as the beginning multiples of the number five: 5, 10, 15, 20, __, __, __.

Use patterns as brief, change-of-pace activities throughout the year. Create new patterns that correlate to the mathematical topics your students are studying.

Complete the Pattern

1 2 3 4 ○ ○ ○

Name & Rule:____

2 4 6 8 ○ ○ ○

Name & Rule:____

1 3 5 7 ○ ○ ○

Name & Rule:____

4 8 12 16 ○ ○ ○

Name & Rule:____

10 20 30 40 ○ ○ ○

Name & Rule:____

100 50 25 12.5 ○ ○ ○

Name & Rule:____

3 9 27 81 ○ ○ ○

Name & Rule:____

1 4 9 16 ○ ○ ○

Name & Rule:____

1 8 27 64 ○ ○ ○

Name & Rule:____

Assorted Puzzlers Instructions

The next six pages contain varied examples of change-of-pace activities with some mathematical orientation. For these activities, I would recommend that you make a transparency for each of the six pages and present the examples to your class one at a time over a period of weeks. Check in the Answer Key Section of this text for a brief explanation of each "Puzzler" before you present it to your class so you can present them in a sequence that suits your educational objectives and instructional style. Ask students who believe that they have the answer to avoid blurting out their ideas until most of the students have had a chance to reflect on the problems.

Challenge your students to modify these problem-solving activities or to create additional "Puzzlers" of their own to use with their classmates at a later date.

Assorted Puzzlers

Watch Your Assumptions

Among the assertions made in this problem situation, there are three errors. Can you identify them?

1. **2 divided by 2 = 4**
2. **4 divided by 1/2 = 2**
3. **3 1/5 multiplied by 3 1/8 = 10**
4. **7 - (-4) = 11**
5. **-10 multiplied by (6 - 6) = 0**

What's My Number? #1

Use the following five clues to help you identify the missing number.

1. It is a three digit number	*What is the range?*
2. It is less than 200	*Now, what is the range?*
3. It is divisible by 12 and 9	*What numbers are left?*
4. It is not a square number	*What does this eliminate?*
5. Its tens digit > its units digit	*What is left?*

The number is ______________________________

What's My Number? #2

Use these 5 clues to help you identify the number.

1. **It is a four digit number**	*What is the range?*
2. **All of its digits are odd**	*How does this help?*
3. **All of its digits are different**	*What is the range?*
4. **The thousands digit is the smallest counting number**	*How does this help?*
5. **It is less than 40 times 40**	*What is the range?*
6. **Its tens digit is less than its units or hundreds digits**	*How does this help?*
7. **The sum of its first & last digits equals the sum of its middle digits**	*What is left?*

The number is ______________________________

Boomerang

How can you throw a ball with all your might, then make it stop and come straight back to you? The ball can't hit a wall or any other object, nor can you attach string, tape, or anything else to it.

Sock Confusion #1

Your sock drawer contains 10 white socks and 10 black socks. Unfortunately, the socks are not sorted into pairs. If someone blindfolded you, what is the minimum number of socks you could take from the drawer and still be certain that you had a matched pair (assume you don't care about the color)?

Sock Confusion #2

Same situation, but this time you want to be sure that you select a pair of white socks. What is the minimum number of socks you can take from the drawer and still be certain that you get a pair of white socks?

The Rise and Fall of the Rope Ladder

There is a rope ladder hanging over the side of a small fishing boat. The bottom rung of the ladder is just touching the top of the water surface. The rungs on the ladder are all exactly 9 inches apart. When the tide is at its highest, the water level will have risen 3 feet (recall that there are 12 inches in a foot). How many of the rope ladder's rungs will be under water at that time?

This Problem is Not a Yolk

You are standing on a cement floor holding a fresh farm egg. You have no cushions or any other materials. Can you drop the egg three feet without breaking its shell?

Centennial Digits

Can you use the digit 9 four times so the result is 100?

The Amoebae Jar

The number of amoebae in a jar doubles every minute. If the jar was completely full after one hour, at what time was it only half full?

A Hefty Problem

A butcher is 33 years old, 6 feet 2 inches tall, and wears size 13 shoes. What do think he weighs?

Sequential Digits

Can you discover four consecutive odd numbers which add up to 80?

Jug Puzzler #1

You have jugs of 8 and 3 liters. There is a water tap nearby. Can you use the jugs to measure exactly 4 liters of water?

Jug Puzzler #2

The same idea, but now you have jugs of 4 and 2 liters. Can you use the jugs to make exactly 3 liters of water?

Mystery Numbers #1

1. This number is the only even prime number. What is it?
2. This number is the only counting number that is neither prime nor composite. What is it?
3. This number is a whole number, but it is not a factor of any counting number. What is it?
4. This number is a two-digit prime number greater than 20. The product of the number's digits is less than 5 and the sum of its digits is divisible by 4. What is it?
5. This two-digit odd number is less than 20. It is also a composite number. What is it?
6. This palindromic number has three digits. It is also a perfect cube. What is it?
7. This is the smallest number (other than 1) that is both a perfect square and a perfect cube. What is it?
8. This three-digit odd number is divisible by 5. The sum of its digits is a perfect square. The product of its digits is 15. The number is greater than 12^2. What is it?
9. This three-digit odd number has units and tens digits that are the same. It is the sum of three different odd perfect cubes. What is it?
10. This number is an even multiple of 5 and a factor of 50. It is also one greater than a perfect square and two greater than a perfect cube. What is it?

Riddles

(Present these riddles for a light-hearted change of pace.)

1. A farmer had 17 sheep. However, all but 9 died. How many sheep does the farmer have left?
2. How much dirt can you remove from a hole that is 3 feet deep, 2 feet wide, and 10 feet long?
3. Take two apples from three apples and what do you have?
4. I have two coins that total 75 cents. One of the coins is not a quarter. What are the two coins?
5. What is the smallest number of birds that could fly in this formation: two birds in front of a bird, two birds behind a bird, and a bird between two birds?
6. Two people were playing chess. They played five games and each won the same number of games, but there were no draws. How is this possible?
7. You are the pilot of an airplane that flies the 1,000 miles from Chicago to New York at 250 miles per hour. The plane makes one stop for thirty minutes in Cleveland. What's the pilot's name?
8. Which is correct: "8 and 8 are 15" or "8 and 8 is 15?"
9. If you had a match and entered a room in which there were a kerosene lamp, an oil heater, and a wood burning stove, which item would you light first?
10. An archaeologist claims he found a gold coin that was dated 45 B. C. Do you believe him? Why or why not?
11. How can you make the odd number 7 even?

Guess My Rule Instructions

This is a fun activity you can use several times each week throughout the school year as a change-of-pace activity for your students. Photocopy the following page and make a transparency to share with the whole class using an overhead projector.

You start the activity by thinking of a "rule" such as "whatever number your students give, you will multiply the number by 3 and add 5 to the result." Next, ask your students to give you a number. Apply your rule to the number and tell the students the resulting answer (e.g. if you were given 2 for the above rule, you would answer "11" since 2 x 3 + 5 = 11). Record the answer on the transparency by placing the number the class gives (2 in this example) in the column headed "Number Offered" and placing the result (11 in this example) to the right of it in the column headed "The Result."

Challenge your students to determine what rule you are using by studying the pattern between the Number Offered and The Result. When someone thinks they know the rule, ask him/her to give you a number and tell you what the result would be. Continue until most of the class have guessed your rule, then ask the first student to give the rule (in this case, "3 times the number plus 5" or "F(n) = 3n + 5" if the class has studied functions). If the student is correct, he/she thinks up a new rule for the class to guess and takes your place in the activity.

Guess My Rule

Trial	Number Offered (n)	The Result F(n)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		

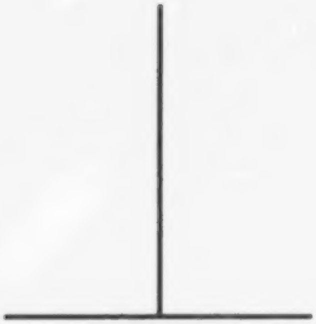
The Rule is ______________________________

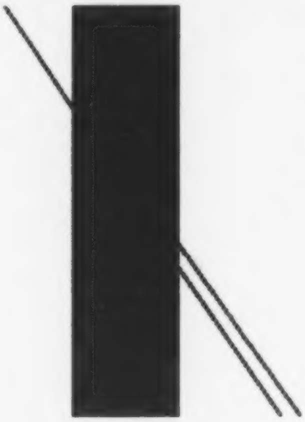
Grand Delusions Instructions

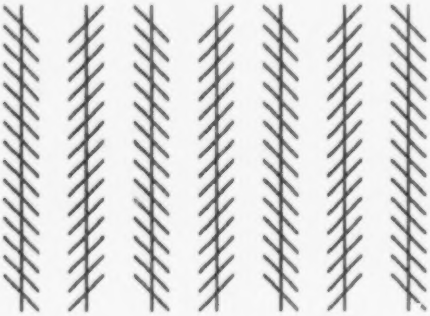
The next three pages contain examples of optical illusions. In my experience, students enjoy these illusions and find them a welcome change-of-pace activity. You can surprise them with the activity on occasions throughout the school year. Each of the "Grand Delusions" represents a visual form whose appearance is deceptive. For example, in the first "Grand Delusion," is the vertical line really longer than the horizontal line? Although the vertical line appears to be the longer of the two, if you measure them, you will find that they are of the same length.

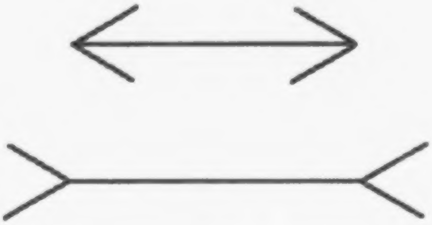
For these activities, I would recommend that you make a transparency from each of the three pages and present the examples to your class one at a time over a period of weeks. Check in the Answer Key Section of this text for a brief explanation of each illusion before you present it to your class so you can prompt them on what to look for. Each time that you present an illusion, ask your students to try to determine what aspect of the visual effect is creating the deceptive appearance. Challenge your students to create additional illusions of their own to use with their classmates at a later date.

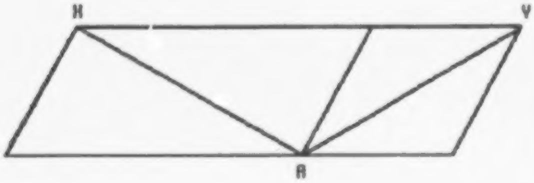
Grand Delusions I

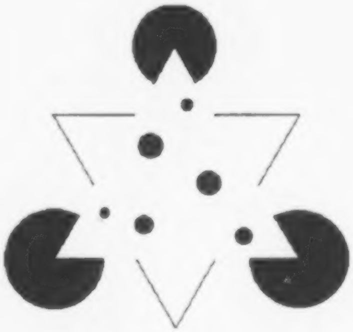




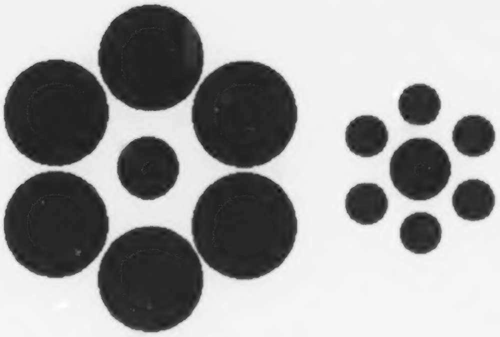


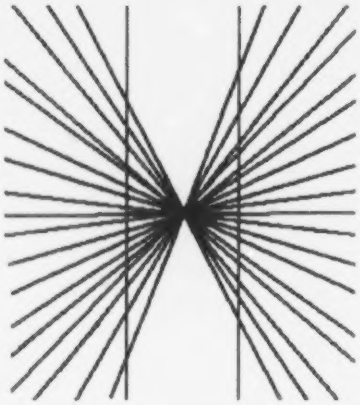


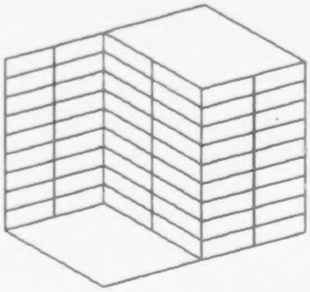


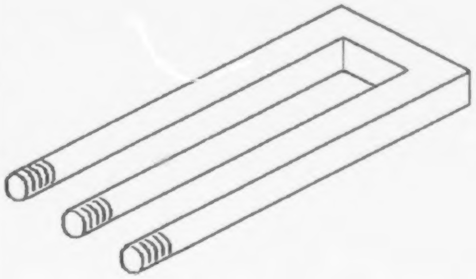


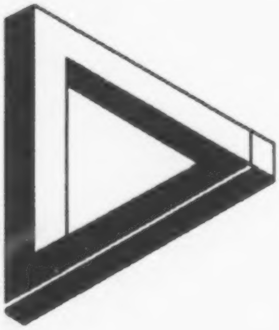
Grand Delusions II

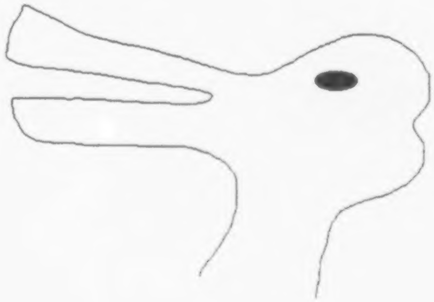




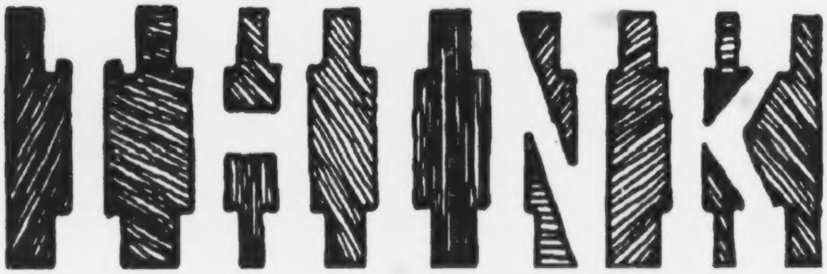


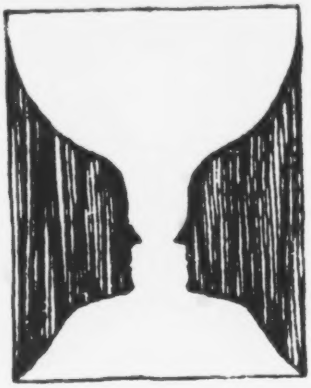


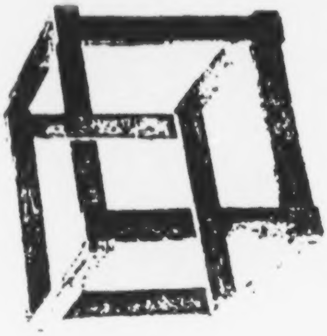


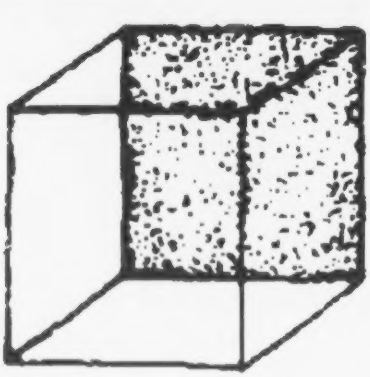


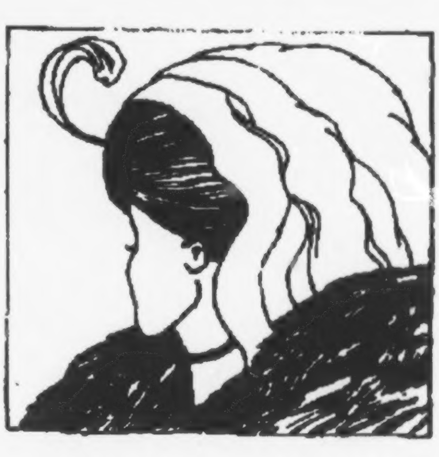
Grand Delusions III











Chapter 7.
Middle-Duration Activities

Middle duration activities will probably require from 10 to 45 minutes, depending on the activity's purpose and the instructional approach you adopt. These activities also serve a variety of purposes. They keep students involved in problem-solving experiences during the school day—across curricular boundaries. Some of these activities can be used, with variations, throughout the school year. Other activities you would only use one time may still trigger follow-on activities or ideas that either you or your students suggest.

The manner in which you use the activities will naturally influence the amount of time they take in class. For the most part, the activities are designed to last a short time (10 to 45 minutes), serving either as a variation in the class routine or as an opportunity to focus on problem solving for an entire class period. The activities may require a longer (or shorter) amount of time depending on the ages, ability levels, and problem-solving backgrounds of your students. Some activities may need to be modified significantly before they are instructionally appropriate.

Some activities (e.g. *What's a Farmer to Do?*) offer role-playing opportunities that may involve students who frequently resist problem-solving experiences. Students may come to enjoy and look forward to (or even ask for) on-going activities (e.g. *Twenty (or so) Questions* and *Can You Explain This?*). Still other activities (e.g. *Diverse Mysteries* and *Puzzlers*) challenge students to think about problem situations.

There are also activities (e.g. *Pyramid Inversion* and *Keep Your Balance*) that challenge students to play with geometric and logical concepts; activities (e.g. *Moving Matches*) that ask students to engage in creative problem solving; activities (e.g. *Digital Arrangements*) that challenge students to play with numbers; and activities (e.g. *Hi School Dilemma*) that introduce students to the use of memory charts.

Can You Explain This? or How is this Possible?

This on-going activity can be used throughout the school year with different content areas. Plan on devoting roughly 10-20 minutes each time you use the activity. The concept is especially appropriate for use with natural science topics, although the activity can be modified for use in social studies, language arts, health, or mathematics classes. The first time you use the activity, pose a *dilemma* to your students and ask them to brainstorm suggestions to explain the situation. The purpose is to suggest open-ended problems without immediate solutions. Ideal problems are those for which you (as Teacher) have no real solution. The process is the key part of this activity, not any solution you or the class may discover.

For example, one morning as I was jogging along a trail through a field of waist-high grass, I came across a spider web attached to two small trees and stretched across the trail roughly 4 feet above the ground. When I went to school that morning, I asked my sixth grade students to explain how that web could possibly have come to be there (i.e. how did the spider manage to stretch a web between those two small trees with all the interfering grass and similar obstacles). Our ensuing discussion lasted more than 30 minutes. During that half hour, many students suggested possible solutions to the question, "How is this possible?"

After the discussion, students (of course) asked "Well, how did the spider manage to do it?" When I told them that I had no idea what the real answer was, they were amazed (and, initially, annoyed). "Aren't you supposed to know the answer?" they challenged. The students then engaged in a lengthy investigation that included accessing parents, siblings, friends, libraries, and other sources. The destination was far less valuable than the journey—teachers don't know everything and, sometimes, we have to find out for ourselves.

Topic Suggestions

- **What makes the wind blow?**
- **What makes seasons?**
- **Where does the wind stop?**
- **What makes people prejudiced?**
- **How did holidays start? (e.g. Halloween)**

Moving Matches Instructions

Use *Moving Matches* activities, such as the examples listed on the following page, periodically throughout the school year. Generally, give your class the challenge at the end of class (or at the end of the day) and let them develop possible solutions overnight (or over the weekend).

First, ask students to find some solution to each activity. Next, ask them to see if they can identify alternative but valid solutions to the same activity. In addition, challenge your students to create other *Moving Matches* activities on their own, similar to the one the class has just solved, and use these activities as additional reinforcements with the whole class later in the school year. Photocopy the next page and use it as a worksheet to distribute to your class or (preferably) make a transparency from the page and present the examples to your class one at a time over a period of weeks.

One important note: each stroke in the examples represents one match stick. Therefore, the first example consists of 12 matches since "*IX*" uses 3 matches, "+"uses 2 matches, "*V*" =uses 2 matches, "=" (the equal sign) uses 2 matches, and "*III*" uses 3 matches. Be certain to explain this to your students, since the drawings do not make that relationship very clear.

Moving Matches

1. Move one match to form a true equation.

   IX + V = III

2. Move one match to form a true equation.

   I - III = 11

3. Move two matches to form a true equation.

   X + V + I = I

4. Move one match to form a true equation.

   IV = IV - I

5. Make two triangles using five matches.

   I I I I I

6. Make five triangles using nine matches.

   I I I I I I I I I

7. Make this a true equation without touching anything.

   XI + I = X

8. ____

   ? __________ ?

Twenty (or so) Questions

This on-going activity can be used with different content areas periodically throughout the school year. Plan on devoting roughly 5-10 minutes each time. The first time, tell your students that you have adopted the identity of a famous person from American History (for instance) and their task is to guess who you are. Each student can ask one (and only one) question that can be answered "yes" or "no." If you answer all of their questions without them guessing who you are, you win and can choose another character the next time. If one of the students guesses your identity, he/she runs the next activity.

To make the order in which students ask their questions more equitable, number your students from one to twenty-whatever. Next, fill a box with pieces of paper numbered from one to twenty-five (or however many). Have a student draw a number from the box; whoever has that number asks the first question and then draws the next number. Continue until someone guesses your identity or everyone has asked a question.

Content Suggestions

Famous Americans
States
Countries
Historical Event
Geometric figure
Literary character
Local celebrity
Explorers
State capitals
National capitals
Student in your class
Invention
Book
? ____________________ ?

Rule Variations

No alphabetical questions
No specified content area
No chronological questions
? ____________________ ?

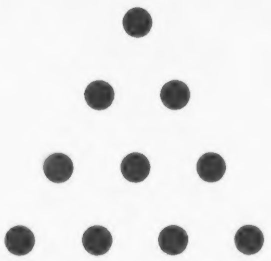
More Puzzlers Instructions

The next two pages contain varied examples of change-of-pace activities with a mathematical orientation. For these activities, I would recommend that you make a transparency for each of the pages and present the examples to your class one at a time over a period of weeks. Check in the Answer Key Section of this text for a brief explanation of each "Puzzler" so you can present them in a sequence that suits your educational objectives and instructional style.

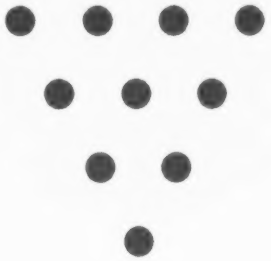
Ask students who believe they have the answer to avoid blurting out their ideas until most of the students have had a chance to reflect on the problems. Challenge your students to modify these problem-solving activities or to create additional "Puzzlers" of their own to use with their classmates at a later date.

More Puzzlers

Pyramid Inversion

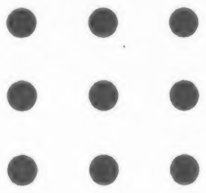


Arrange 10 circular objects in the pattern indicated above. Now, move only 3 of the objects so that the pattern is reversed as illustrated below.



Connect the Dots

Connect the nine circles in the array shown below. You can only use four straight lines and cannot lift your pen from the paper once you begin drawing. The four lines can cross.



Keep Your Balance I

You have 13 balls, all of which are identical in size and appearance. 12 of the balls weigh the same, but the other one is slightly heavier. Using a pan balance, how can you identify the heavier ball in just three weighings?

●●●●●●●●●●●●●

Keep Your Balance II

Now, you have 25 balls, all of which are identical in size and appearance. 24 of the balls weigh the same, but the other one is slightly heavier. Using a pan balance, how can you identify the heavier ball in just four weighings?

●●●●●●●●●●●●●●●●●●●●●●●●●

The Hi School Student Dilemma Instructions

The next two pages contain an activity that lends itself to the use of a memory chart. For this activity, I would recommend that you photocopy the two pages and distribute them to each of your students for individual reflection overnight. Briefly explain to them that the memory chart will prove useful by helping them keep track of each young lady and the school position that she holds. During the next class session, make a transparency of the second page and use it to demonstrate for the class how to use the chart to handle the information presented on the first page.

Challenge your students to modify this activity to create other examples (perhaps based on the students in your class or their friends) that require the use of a memory chart, to use with their classmates at a later date.

The Hi School Student Dilemma

Ann, Barbara, and Carol all attend Hi School. This year they fill these roles:

- Cheerleader
- Student Body President, and
- Captain of the Girls' Basketball Team

Use the following clues to figure out which of the young ladies holds each position.

1. After the last basketball game, the Captain looked for the Student Body President, but the President had already left with Barbara.
2. The President is older than the Captain.
3. Ann is older than Barbara.
4. Carol had never met the President.

The Hi School Memory Chart

Student Roles:

- Cheerleader
- Student President
- Captain of the Girls' Basketball Team

STUDENT	POSITION
Ann	
Barbara	
Carol	

Diverse Mysteries Instructions

The next three pages contain varied examples of change-of-pace activities with a definite mathematical orientation. For these activities, I would recommend that you make a transparency for each of the pages and present the examples to your class one at a time over a period of weeks. Check in the Answer Key Section of this text for a brief explanation of each "Diverse Mystery" before you present it to your class so you can present them in a sequence that suits your educational objectives, the mathematics skill level of your students, and your instructional style. Ask students who believe they have the answer to avoid blurting out their ideas until most of the students have had a chance to reflect on the question.

Challenge your students to modify these problem-solving activities or to create additional "Diverse Mysteries" of their own to use with their classmates at a later date.

Diverse Mysteries I

1. Twice a number equals three times the same number. What is the number?

2. The sum of this number's two digits is 5. If you reverse the number's digits, the resulting number is 9 less than the original number. What is the original number?

3. Create any number you like using all of the first nine counting numbers (i.e. 1, 2, 3, 4, 5, 6, 7, 8, 9). By what number is any number formed with these digits divisible?

4. Can you identify three digits to replace the letters Z, A, and P in these three equations?

   Z + Z = P   Z x Z = A   A - Z = P
   Z = ___   A = ___   P = ___

5. Can you identify two digits to replace the letters Y and Z to make this a true equation?

   Y + Y + Y = ZY   Y = ___   Z = ___

6. See if you can insert addition and subtraction signs in the number sequence below to create a true equation.

   9 8 7 6 5 4 3 2 1 0 = 100

7. Can you replace the letters A, B, C, D, and E with unique digits to make this a true equation?

$$\begin{array}{r} ABCDE \\ \times\, 4 \\ \hline EDCBA \end{array}$$

   A = ________   B = ______   C = ______
   D = ________   E = _______

Diverse Mysteries II

1. See if you can divide $6 among three boys so that the following rule holds true: for every 3¢ the first boy gets, the second boy gets 5¢, and the third boy gets 7¢. How much will each boy receive?

2. Identify four consecutive odd numbers that add up to 120.

3. Can you identify three digits to replace the letters Z, Y, and A to make this a true equation?

$$\begin{array}{r} Z\,Z\,Z \\ +\quad\quad Y \\ \hline Y\,A\,A\,A \end{array}$$

Z = ___
Y= ___
A = ___

4. Can you identify three digits to replace the letters A, B, and C to make this a true equation?

$$\begin{array}{r} A\ A \\ +\ \ A\ A \\ \hline B\ B\ C \end{array}$$

A = ___
B = ___
C = ___

5. Can you replace the letters A, H, and E to make this a true equation?

$$\begin{array}{r} HA \\ HA \\ +\ HA \\ \hline EH \end{array}$$

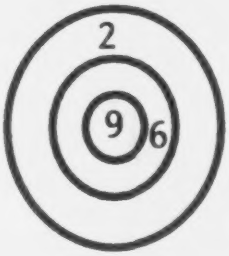
H = ___
A = ___
E = ___

6. See if you can insert addition and subtraction signs in the number sequence below to create a true equation.

1 2 3 4 5 6 7 8 9 0 = 100

Diverse Mysteries III

1. Ann and Sarah are playing a ball toss game at the county fair. To play the game, you try to toss balls into one of 3 concentric baskets. Each basket is worth a different number of points—the largest basket is worth 2 points, the middle basket is worth 6 points, and the smallest basket is worth 9 points (see below). To win the grand prize, you must score exactly 34 points. What is the fewest number of balls needed to produce a score of 34?



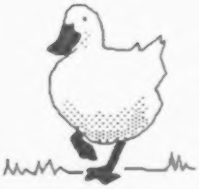
2. For this problem, you can only use the digits 0, 1, 2, 3, 6, 7, and 9 to replace the letters T, O, Y, J, R, I, and P. See if you can determine which letter represents which digit to make this a correct operation.

$$\begin{array}{r} T\ O\ Y \\ +\ J\ O\ Y \\ \hline T\ R\ I\ P \end{array}$$

T = ___
O = ___
Y = ___
J = ___
R = ___
I = ___
P = ___

3. Can you discover three consecutive even numbers that add up to 123?

The Narrow Bridge: What's a Farmer To Do? Instructions



A Farmer owned a Duck, a Wolf, and a container filled with Corn. He was taking the three possessions to sell them at market.

However, on the way to market, he came to a wide river spanned by a very narrow bridge. The bridge was so narrow that he could only take one possession at a time across the bridge.

Here is the problem: if he leaves the Wolf and Duck alone, the Wolf will eat the Duck. Similarly, if he leaves the Duck and Corn together, the Duck will eat the corn.

What's a Farmer to do in a dilemma like this?

PS: Use the next three pages for your students to role play the Farmer's plight so that the whole class can get involved in the solution process—guiding the Farmer to market!

The Narrow Bridge: What's a Farmer To Do?

THE

WOLF

WILL EAT THE

DUCK

GIVEN A CHANCE

The Narrow Bridge: What's a Farmer To Do?

THE

CORN

WILL BE EATEN

BY THE DUCK...

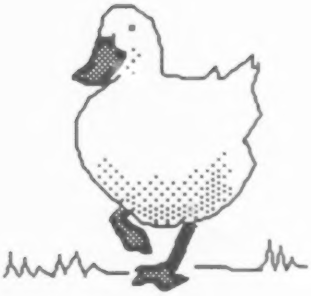
IF NOT

PROTECTED

The Narrow Bridge: What's a Farmer To Do?

THE

DUCK



WILL EAT THE CORN

GIVEN A CHANCE

WILL BE EATEN

BY THE WOLF...

IF NOT PROTECTED

Still More Puzzlers Instructions

The next three pages contain varied examples of change-of-pace activities with a definite mathematical orientation. For these activities, I would recommend that you make a transparency for each of the pages and present the examples to your class one at a time over a period of weeks. Check in the Answer Key Section of this text for a brief explanation of each "Puzzler" before you present it to your class so you can present them in a sequence that suits your educational objectives, the mathematics skill level of your students, and your instructional style. Ask students who believe they have the answer to avoid blurting out their ideas until most of the students have had a chance to reflect on the problems.

Challenge your students to modify these problem-solving activities or to create additional "Puzzlers" of their own to use with their classmates at a later date.

Still More Puzzlers

1. There are fewer than 72 eggs in a basket. Counted by 2s, there is one egg left over. Counted by 3s, they come out even. Counted by 4s, 5s, or 6s, there are always three eggs left over. How many eggs are there?
2. Use the digits from 0 through 9 in pairs so that each pair has the same sum in an addition problem.

__ + __ = ?   __ + __ = ?   __ + __ = ?   __ + __ = ?

3. Use the digit 9 three times to produce a result of 11.
4. Use the digit 9 five times to produce a result of 10.
5. Use the digit 6 four times to produce a result of 42.
6. Use the digit 5 four times to produce a result of 25.
7. Use the digit 3 five times to produce a result of 31.
8. This two-digit even number is divisible by 9. The sum of its digits is a perfect square. The number is less than 8^2. The product of its digits is 20. What is it?
9. This three digit even number is less than 20^2. The number's units and tens digits are the same. It's the sum of three different even perfect cubes. What is it?
10. This number is an odd multiple of 7 and a factor of 210. It is also five greater than a perfect square and 20 less than a perfect cube. What is it?

Digit Dilemma

For this problem you can use the digits 1, 2, 3, 4, 5, 6, 7, 8, and 9. See if you can arrange the nine digits in such a way that they add up to 99, 999.

Alphabetical Mathematics #1

Substitute digits for the letters A and M to make this equation correct.

$$\begin{array}{r} MA \\ +\underline{\quad A} \\ AM \end{array}$$

M = ____ A = ____

Alphabetical Mathematics #2

Replace the letters O, N, E, T, and W with digits to make this equation correct.

$$\begin{array}{r} ONE \\ +\underline{\ ONE} \\ TWO \end{array}$$

O =___ N =___ E =___
T =___ W =___

Figure It Out #1

Can you produce a result equal to 3 using only the digit 3 three times?

Figure It Out #2

What number is equal to three times the sum of its digits?

Figure It Out #3

What four consecutive numbers add together to equal 94?

Digital Arrangements

1. Use the digit 5 four times to produce a result of 25.
2. Use the digit 7 three times to produce a result of 56.
3. Use the digit 9 three times to produce a result of 11.
4. Use the digit 7 four times to produce a result of 56.
5. Use the digit 6 four times to produce a result of 42.
6. Express 10 using only the digit 8 two times.
7. Use the digit 3 five times to produce a result of 31.
8. Use the digit 4 seven times to produce a result of 100.
9. Use the digit 9 five times to produce a result of 10.
10. Produce a result of 12 using the same digit three times (but don't use 4 or 1).
11. Use the digit 8 eight times (and only one mathematical operation) to produce a result of 0.
12. Use the digit 5 four times to produce a result of 56.
13. Use the digit 9 nine times to produce a result of 1,000.
14. Use three of the same digit (your choice) to produce a result of 30. How many different ways can you make 30?
15. Use the number 10 ten times to produce a result of 1.

Chapter 8.
Long-Duration Activities

Longer duration activities generally require a full class periodor an extended period such as an overnight or weekend—depending on the activity's purpose and the instructional approach you adopt. These activities also serve a variety of purposes. They keep students involved in problem-solving experiences during the school day and beyond. These activities extend problem solving beyond the confines of the school ground and the school day.

The manner in which you use the activities will naturally influence the amount of time that they take. The activities may need to be modified (perhaps simplified) depending on the ages, ability levels, and backgrounds of your students. For some activities there are Guidesheets provided to allow you to make the activities more appropriate for your students. Offer whatever hints you deem appropriate.

Some activities (e.g. *Cuisenaire Builders*) offer role-playing opportunities that involve students in communication experiences that help them appreciate the value of clear and succinct instructions. Students may come to enjoy and anticipate on-going activities (e.g. *Tangrams, The Game of NIM,* and *Calendar Developers*). There are also activities (e.g. *Sporting Sorting*) that ask students to solve problems with Venn Diagrams; activities (e.g. *Non-Vulcan Mind Meld*) that ask students to engage in creative problem solving; and activities (e.g. *Death-Star Rock Group, Business Disorder,* and *Cooperative Chaos*) that offer students practice in using memory charts.

Cuisenaire Builders Instructions

The next five pages contain an activity designed to help your students reflect on the complexity of communicating ideas orally. For this activity, arrange your students into cooperative groups of three. I would recommend that you photocopy the pages and distribute them to each of the triads. Make copies of the first and last pages for each student. For the other three pages (The Builder, The Copier, and The Observer), one copy for each group is sufficient.

Explain to your class that giving and following oral instructions is quite difficult. This activity will help them understand some of difficulties involved. Have students read the instructions on the first page and clarify any points of confusion. Allow 10 to 15 minutes for each Builder to create a design, issue instructions to The Copier, and have the experience debriefed by the Observer. Ask students to keep their designs simple enough to be completed within that time period.

As a follow-up to this activity, give your students a piece of graph paper and ask them to create a simple design overnight, using crayons or colored markers. When they have finished the design, ask them to write out the instructions necessary to create their design. The next day, organize your students into pairs and have them exchange descriptions with their partners. Each partner must then create the design using only the written description. When they are finished, have them use their designs to verify results and discuss any points of confusion or inconsistencies.

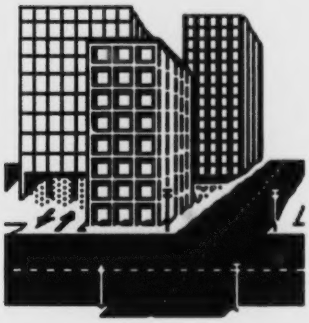
Cuisenaire Builders

In this activity, you will be arranged in teams of three. Each triad will have a package of cuisenaire rods and two pieces of centimeter-square graph paper. Members of the triad will take turns rotating through three roles: Builder, Copier, and Observer. The duties of each role are summarized in the table below. After the first session is complete, the Builder becomes the Copier for the next session, Copier becomes Observer, and Observer becomes Builder. After the second session is complete, each individual assumes the role he/she has not yet performed. Each session should last roughly five to ten minutes.

ROLE	DESCRIPTION
Builder	The Builder creates a simple design using the available cuisenaire rods. As the Builder creates, she gives the Copier the necessary directions to recreate her design. The Builder can't show, only tell. The Builder can't answer questions, only repeat instructions.
Copier	The Copier follows the Builder's directions to duplicate the desired design. While the Builder directs, the Copier follows the Builder's instructions. The Copier can't ask questions, only ask for a repetition of the previous instruction.
Observer	The Observer watches the proceedings to insure that the correct procedures are followed. In addition, the Observer serves as the "debriefer" after the session is completed.

Cuisenaire Builders

THE
BUILDER



Creates a design on graph paper using Cuisenaire Rods.

Gives directions to the Copier as he/she builds.

Cuisenaire Builders

THE COPIER

Follows the Builder's directions to duplicate design.

Can only ask to have a direction repeated.

Cuisenaire Builders

THE
OBSERVER

Ensures that
the Builder and
the Copier
follow the rules.

Debriefs the group
after the design
is complete.

Cuisenaire Builders' Graph Paper

Game of NIM Instructions

NIM is an ancient game for two people that can be played using only pencil and paper or using 15 manipulatives such as sticks, straws, or rods. To play, you arrange 15 marks (or manipulatives) in three rows like those shown below. Introduce the activity to the class by making a transparency of the next page and engaging the whole class in several introductory games.

| | |

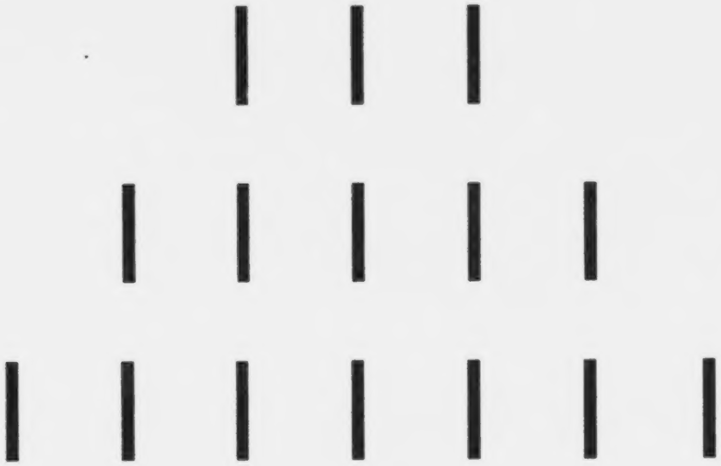
| | | | |

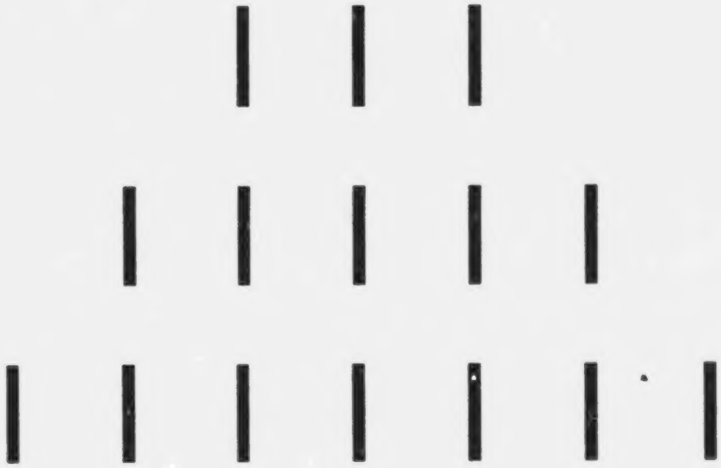
| | | | | | |

Players take turns removing one, two, or three marks—all from the same row. For example, the first player could take 1, 2, or 3 sticks from any of the rows. The object of the game is to remove the last stick from the board. Whoever takes the *last* stick wins the game.

There is a great deal of mathematics underlying this game. Have students look for end-game combinations that guarantee victory (e.g. two marks left on two different rows and it's my turn) and for combinations to avoid because they ensure defeat (e.g. one mark left on two different rows and it's my turn). Pair students to play best 2 out of 3, then have winners and losers play each other. After several rounds, ask the winners to share their strategies with the whole class.

Game of NIM





Who are the Basketball Champs? Instructions

The next page contains an example of an activity that lends itself to the use of a systematic process of elimination. For the activity, I would recommend that you photocopy the page and distribute it to each student for individual reflection overnight.

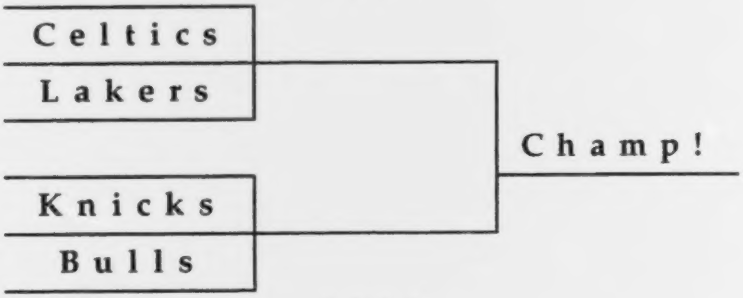
Briefly explain to them that they should read very carefully the clues in the opening paragraph and use the information contained there to complete the championship brackets listed below the paragraph. Before your next class session, make a transparency of the page and use it to discuss with the class how to use the information presented in the paragraph.

Challenge your students to modify this activity to create other examples (perhaps based on the school teams in your district or other professional sports) to use with their classmates at a later date.

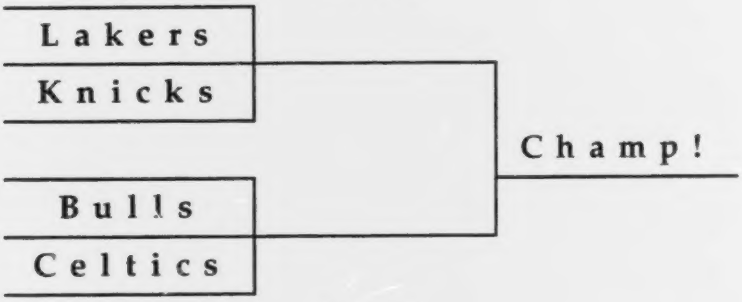
Who are the Basketball Champs?

For this situation, imagine that there were four teams—Lakers, Celtics, Knicks, and Bulls—who played for the professional basketball championships three successive years. A different team won each year. The Knicks lost every round. The Lakers never beat the Celtics, but the Celtics never beat the Bulls. Can you complete the following championship brackets for three years?

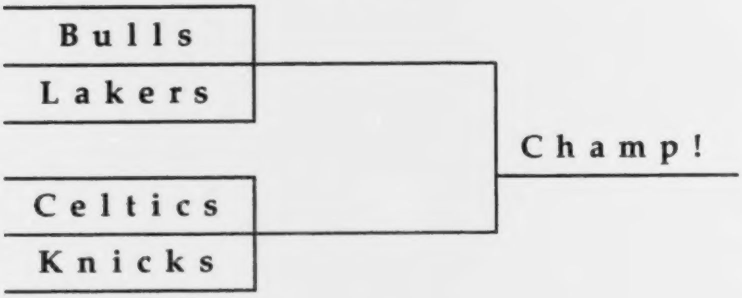
1990


Celtics
Lakers
Knicks
Bulls
Champ!

1991


Lakers
Knicks
Bulls
Celtics
Champ!

1992


Bulls
Lakers
Celtics
Knicks
Champ!

Tangrams Instructions

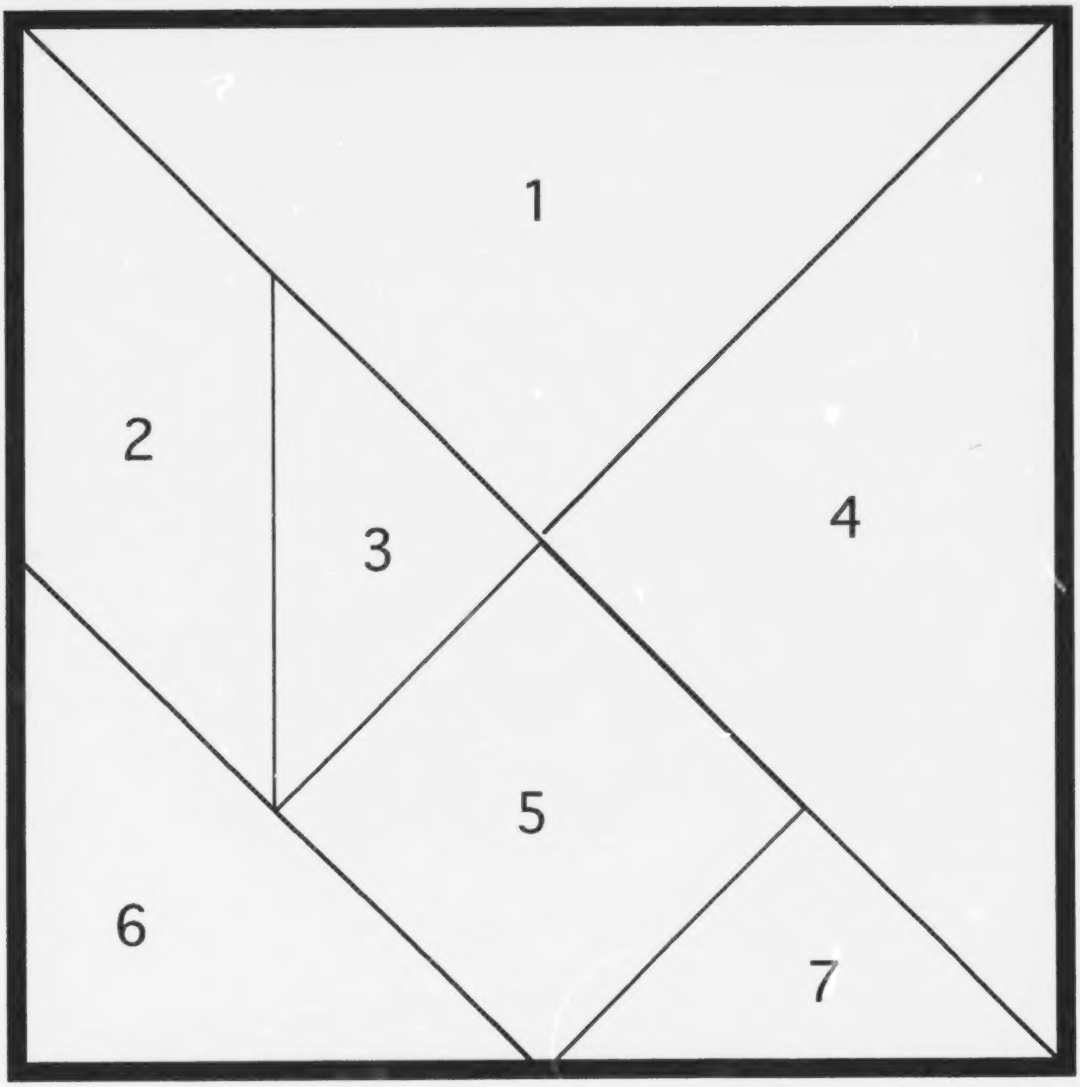
Make a photocopy of the next page and then use scissors to cut the large square along the internal lines. Better still, find some thick cardboard or plastic and trace the square's lines on that material before cutting.

Next, put the seven shapes in an envelope (using the numbered side to indicate which side is up) and challenge your students to reassemble them in such a way that they produce a large square. Make a photocopy of the following page (Tangrams Frame) and give it to your students to use as the outline within which to build their squares.

Have the students look for patterns as they attempt the challenge (i.e. are there certain shapes that can't fit together). Interrupt your students' explorations periodically and ask them to share their discoveries with the rest of the class.

During subsequent class periods, challenge your students to create other shapes and patterns using the same seven shapes. Ask the students to share new discoveries with their classmates.

Tangrams Cutout



Tangrams Frame

The Death-Star Rock Group Instructions

The next two pages contain another example of an activity that lends itself to the use of a memory chart. For this activity, I would recommend that you photocopy the two pages and distribute them to each of your students for individual reflection overnight.

Briefly explain to them that the memory chart will prove useful by helping them keep track of each band member and the instrument that he plays. Before the next class session, make a transparency of the second page and use it to demonstrate how to use the chart to handle the information presented on the first page.

Challenge your students to modify this activity to create other examples (perhaps based on their friends and their activities) that require the use of a memory chart, to use with their classmates at a later date.

The Death-Star Rock Group

The Death-Star rock group has 4 players:

- Brad
- Dan
- Gus
- Hank

The players use these instruments:

- Bass
- Drums
- Guitar
- Horn

Use the following clues to determine which individual plays which instrument.

1. No one plays an instrument starting with the same letter as his first name.
2. Brad does not like the horn player.
3. Hank is the best friend of the drummer.
4. Gus plays the bass.

The Death-Star Rock Group Memory Chart

NAME	BASS	DRUMS	GUITAR	HORN
Brad				
Dan				
Gus				
Hank				

Business Disorder Instructions

The next two pages contain a much more difficult example of an activity that lends itself to the use of a memory chart. For this activity, I would again recommend that you photocopy the two pages and distribute them to each of your students for individual reflection overnight.

Briefly explain that the memory chart will prove useful by helping them keep track of each Coy Toy employee and the position that he/she fills. Before your next class meeting, make a transparency of the second page and use it to demonstrate how to use the chart to handle the information presented on the first page.

Challenge your students to modify this activity to create other examples (perhaps based on their friends and their activities) that require the use of a memory chart, to use with their classmates at a later date.

Business Disorder

The business office of the Coy Toy Company consists of the following individuals, listed in alphabetical order:

- Mr. Brown
- Mr. Case
- Miss Grant
- Mrs. Jen
- Miss Lint
- Mr. O'Shea

Those individuals fill the following positions (but not necessarily in the order listed):

- Teller
- Clerk
- Cashier
- Secretary
- Assistant Manager
- Manager

Use the following clues and the memory chart on the next page to help you determine which individual fills each position.

1. The Assistant Manager is the Manager's grandson.
2. The Cashier is the Secretary's son-in-law.
3. The Teller is Miss Grant's step-sister.
4. Mr. Brown is a bachelor.
5. Mr. Case is 22 years old.
6. Mr. O'Shea is the Manager's neighbor.

Business Disorder Memory Chart

	Assistant Manager	Manager	Cashier	Secretary	Clerk	Teller
Mr. Brown						
Mr. Case						
Miss Grant						
Mrs. Jen						
Miss Lint						
Mr. O'Shea						

Calendar Developers Instructions

This activity can be replicated (with variations and increasing levels of difficulty) each month throughout the school year. The next page contains a blank month for you to photocopy and distribute to your class. The first time you use the activity, ask your students to complete the blank calendar by using one or more whole number operations (i.e. addition, subtraction, multiplication, division) to produce a result equaling each day of the current month. For example, the tenth could have any of the following operations in its location:

- **10 x 1**
- **6 + 4, or**
- **15 + 1 - 6**

The first time you use the activity, control the number of operations that can be used in each date (e.g. no more than two operations, or only addition, or only addition and one subtraction). Have students share the operations they used to achieve each of the days of the month to illustrate that many problems have multiple solutions. Consider posting the calendars on a bulletin board for the class to inspect independently. In later months, limit the digits that can be used (e.g. only odd digits or only 1, 2, 5, and 7) as well as which operations students can use (e.g. only multiplication and addition, or only subtraction and multiplication). Again, have your students share their different solutions for the same problem.

Calendar Developers

		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

Sporting Sorting Instructions

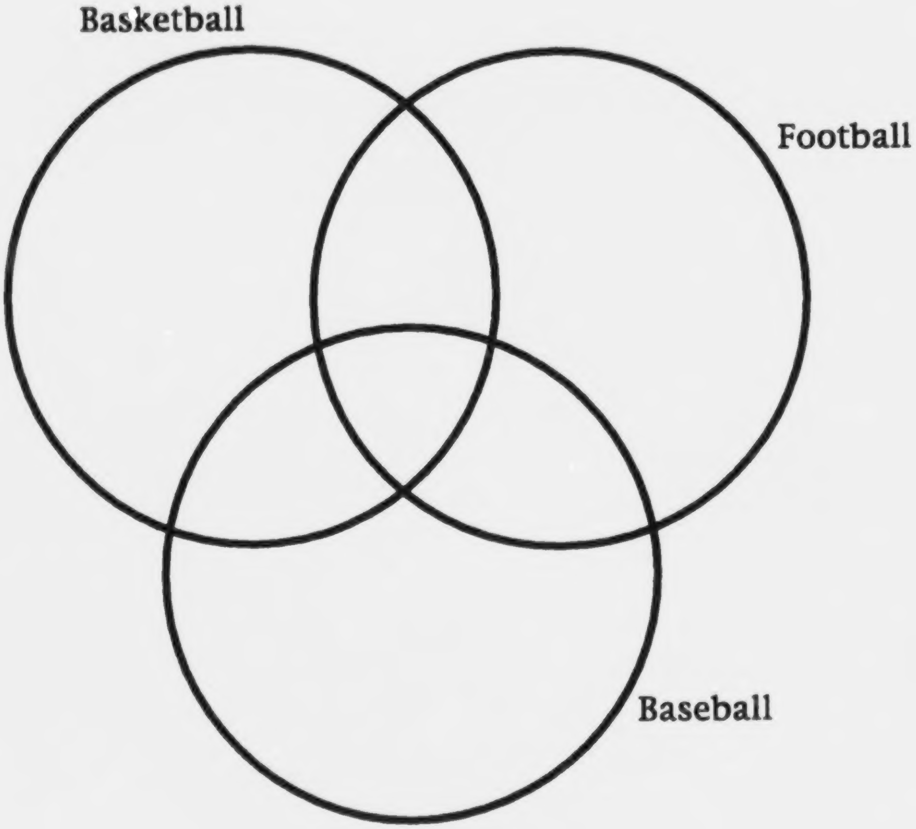
The next two pages contain an example of an activity that lends itself to the use of a Venn Diagram. For this activity, I would again recommend that you photocopy the two pages and distribute them to each of your students for individual reflection overnight. The Guidesheet will help the students get started if they are having trouble.

Briefly explain that the Venn Diagram will help them keep track of each sports team and the number of players on each team. Before your next class meeting, make a transparency of the page showing the Venn Diagram and use it to demonstrate how to use a Venn Diagram to handle the information presented in the eight clues.

Challenge your students to modify this activity to create other examples (perhaps based on your school's sports teams) that require the use of a Venn Diagram, to use with their classmates at a later date.

Sporting Sorting

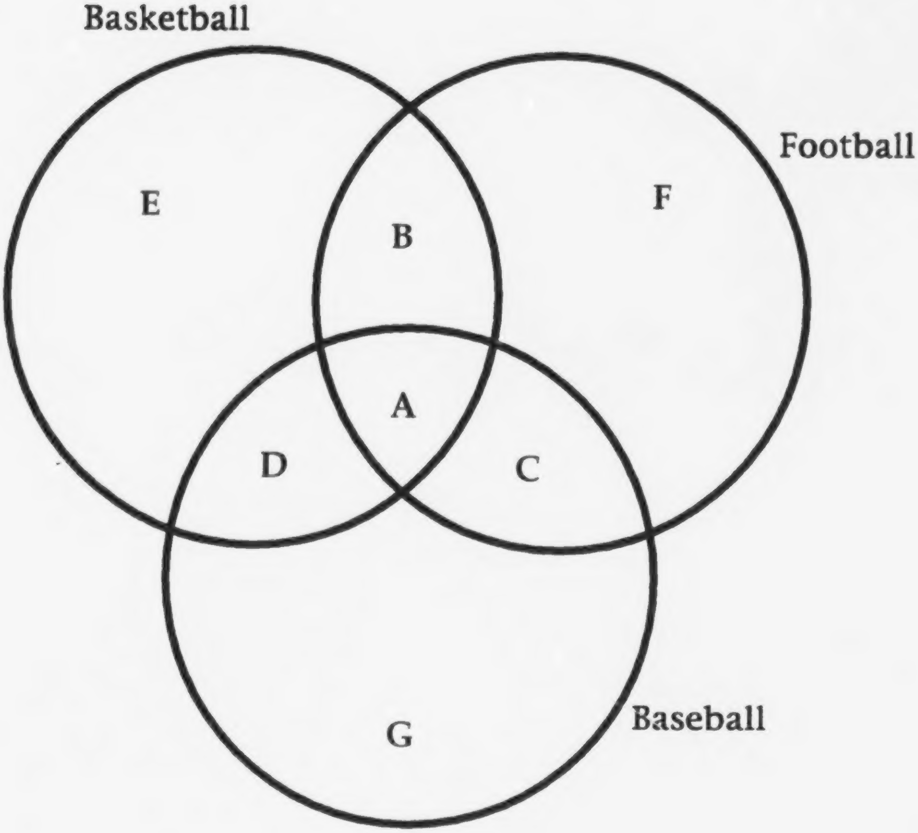
Hi School has three sports teams: basketball, football, and baseball. There are 21 players on the basketball team, 29 on the football team, and 26 on the baseball team. However, 14 players are on both the baseball and basketball teams, 15 play both baseball and football, and 12 play football and basketball. There are 8 individuals who play all three sports. The challenge is to figure out the total number of players. The following Venn Diagram will help you.



Sporting Sorting Guidesheet

The following steps are designed to show how to use a Venn Diagram to solve a problem. Carefully read the information on the previous page before starting to use this Guidesheet with the Venn Diagram that follows.

1. Begin with the 8 players who are on all three teams—put them in Section A.
2. Of the 12 students who play football and basketball, 8 are in Section A because they also play baseball—put the remaining 4 (12 – 8) in Section B.
3. Of the 15 students who play both baseball and football, 8 are in Section A because they also play baseball—put the remaining ones in Section C.
4. Of the 14 students who play both baseball and basketball, 8 are in Section A because they also play baseball—put the remaining ones in Section D.
5. There are a total of 21 players on the basketball team. Since Sections A, B, and D total 18 (they play basketball and other sports)—put the remaining ones in Section E.
6. There are a total of 29 players on the football team. Add Sections A, B, and C (those playing football and other sports)—put the remaining ones in Section F.
7. There are a total of 26 players on the baseball team. Add Sections A, C, and D, then use the same process to determine what to put in Section G.
8. Add the figures in the various sections to produce the total number of players.


Basketball
Football
Baseball
E
B
F
A
D
C
G

Geometric Decoder Instructions

The next two pages contain an activity designed to provide students with practice in logical thinking. For this activity, I recommend that you photocopy the two pages and distribute the first page to each student for individual reflection overnight (or over a weekend). The Guidesheet will help students who are having trouble getting started, but you may want to use it later as well to guide a class discussion.

Briefly explain to your students that in this activity, digits have been replaced by shapes. Their challenge is to determine which digit each shape represents. Before your next class meeting, make transparencies of the pages and use them to demonstrate how to identify which digit one particular shape represents and then substitute that digit in each equation where that shape occurs. Use the Guidesheet to facilitate your instructional process.

Challenge your students to modify this activity to create other examples to use with their classmates at a later date.

Geometric Decoder

In the following equations, shapes have been substituted for the correct digits (6 is not used). Look for recognizable patterns that will help you determine which digit each shape represents. To begin, use a trial and error approach. Each shape stands for the same digit in every equation in which it occurs. Put the correct digits next to the corresponding shapes on the right.

○ + ○ = ●

○ x ○ = ○

○ + ● = ▼

▼ + ▼ + ▼ = ♥

● + ▼ = ❑

♥ x ■ = ■

▼ + ▲ = ◆

▲ + ▲ = ☆

☆ = ____

◆ = ____

▼ = ____

♥ = ____

▲ = ____

❑ = ____

■ = ____

● = ____

○ = ____

Geometric Decoder Guidesheet

If you are uncertain how to begin, the following suggestions should help you get started with this activity

❍ + ❍ = ●	*(see below, use clues together)*
❍ x ❍ = ❍	*(means ❍ = 1 and ● = 2 since 1+1= 2 and 1x1= 1)*
❍ + ● = ▼	*(means ▼ = 3 since ❍ = 1, ● = 2 and 1+ 2 = 3)*
▼ + ▼ + ▼ = ♥	*(means ♥ = 9 since ▼ = 3 and 3 + 3 + 3 = 9)*
● + ▼ = ❑	*(means ❑ = 5 since ● = 2, ▼ = 3, and 2+ 3 = 5)*
♥ x ■ = ■	*(means ■ = 0 since ♥ = 9 and 9 x 0 = 0)*
▼ + ▲ = ◆	*(means ◆ = ? since ▼ = 3 and ? ? ?)*
▲ + ▲ = ✰	*(means ✰ = ? since ? ? ?)*

		3	9		5	0	2	1
✰	◆	▼	♥	▲	❑	■	●	❍

Digital Discovery I Instructions

The next two pages contain an activity designed to provide students with practice in logical thinking and number theory. For this activity, I recommend that you photocopy the two pages and distribute the first page to each student for individual reflection overnight (or over the weekend). The Guidesheet will help students who are having trouble getting started, but you may want to use it later to guide a class discussion.

Briefly explain to your students that in this activity, nine digits have been hidden beneath the nine cards on the bottom of the next page. Their challenge is to determine which digit is beneath each card. Before your next class meeting, make transparencies of the pages and use them to demonstrate to the class how to identify which digit is under each card. Use the accompanying Guidesheet to facilitate your instructional process.

Challenge your students to modify this activity to make other examples to use with the class at a later date.

Digital Discovery I

Use these clues to determine which digit is hidden under each of the nine cards represented below.

1. There are no prime numbers in Column 2.
2. There are no composite numbers in Row 2.
3. The missing digits are 0, 1, 2, 3, 4, 5, 6, 7, 8.
4. All of the digits in Row 2 are odd.
5. The sum of Column 1 is less than 8.
6. No digit is used twice.
7. The digits in Row 3 are even and consecutive.
8. All digits in Columns 2 & 3 & Row 3 are counting numbers.
9. The sum of the four corners equals the sum of Row 1.
10. The digits in Row 2 total 13.

	Column 1	**Column 2**	**Column 3**
Row 1	☐	☐	☐
Row 2	☐	☐	☐
Row 3	☐	☐	☐

Digital Discovery I Guidesheet

To solve this problem, you must be familiar with terminology such as prime and composite numbers, odd and even numbers, and counting numbers. Also, it may be useful to examine the clues out of the numerical order in which they are listed (e.g. clue #3 establishes which nine digits are hidden beneath the cards).

1. No primes in Column 2	*(means only 0, 1, 4, 6, 8 possible)*
2. No composites in Row 2	*(means only 0, 1, 2, 3, 5, 7 possible)*
3. Digits are 0, 1, 2, 3, 4, 5, 6, 7, 8	*(establishes possible digits)*
4. Digits in Row 2 are odd	*(means only 1, 3, 5, 7 possible)* *(also means 1 is Column 2—Row 2)*
5. Sum of Column 1 is less than 8	*(means Column 1 numbers small)*
6. No digit is used twice	*(establishes all digits are unique)*
7. Digits in Row 3 are all even and consecutive	*(means only 0, 2, 4, 6, 8 are possible)*
8. Digits in Columns 2 and 3, and Row 3 are all counting numbers	*(means 0 is Column 1—Row 1)*
9. Sum of four corners equals sum of Row 1	*(useful as last clue)*
10. Digits in Row 2 total 13	*(means only 1, 5, 7 possible)*

Digital Discovery II Instructions

The next two pages contain another activity designed to provide students with practice in logical thinking and number theory. For this activity, I recommend that you photocopy the two pages and distribute the first page to each student for individual reflection overnight (or over the weekend). The Guidesheet will help students who are having trouble getting started, but you may want to use it later to guide a class discussion.

Briefly explain to them that in this activity, nine digits have been hidden beneath the nine cards on the bottom of the next page. Their challenge is to determine which digit is beneath each card. Before your next class meeting, make transparencies of the pages and use them to demonstrate to the class how to identify which digit is under each card. Use the accompanying Guidesheet to facilitate your instructional process.

Challenge your students to modify this activity to make other examples to use with the class at a later date.

Digital Discovery II

Use these clues to determine which digit is hidden under each of the nine cards represented below.

1. The digits 1, 2, 3, 4, 5, 6, 7, 8, 9 each appear under a card.
2. Numbers in Row 1 are factors of 30.
3. Row 1 contains three consecutive odd numbers.
4. The four corners are all odd numbers.
5. Each digit in Column 2 (Row 2 and 3) is double the digit over it.
6. Numbers in Column 1 are factors of 72.
7. The sum of Row 2 is 16.
8. One of the diagonals contains prime factors of 84.
9. The sum of Column 1 is equal to the sum of Row 3.
10. The sum of Column 3 is twice the sum of Row 1.

	Column 1	**Column 2**	**Column 3**
Row 1			
Row 2			
Row 3			

Digital Discovery II Guidesheet

To solve this problem, you must be familiar with mathematical terminology such as factors, prime factors, odd and even numbers, and consecutive numbers. Also, it may be useful to examine the clues out of the numerical order in which they are listed (e.g. clue #3 establishes which nine digits are hidden beneath the cards).

1. Numbers in Row 1 are factors of 30 *(means only 1, 2, 3, 5, 6 possible)*
2. Row 1 contains 3 consecutive odd numbers *(means only 1, 3, 5 possible)*
3. Digits 1, 2, 3, 4, 5, 6, 7, 8, 9 appear *(establishes possible digits)*
4. The four corners are all odd numbers *(means 7 and 9 in Row 3)*
5. Digits in Column 2 are all double the digits over them *(means Column 2 must be 1, 2, 4)*
6. Numbers in Column 1 are factors of 72 *(means only 3, 6, 8, 9 possible)*
7. The sum of Row 2 is 16 *(means sum of Column 1 and 3 digits in Row 2 is 14—only 6 and 8)*
8. One diagonal has prime factors of 84 *(means one diagonal has 2, 3, 7)*
9. Sum of Column 1 equals sum of Row 3 *(means both equal 20)*
10. Sum of Column 3 is twice sum of Row 1 *(means Column 3 sum equals 18)*

Find My Word I Instructions

The next two pages contain another activity designed to provide students with practice in logical thinking. For this activity, I recommend that you photocopy the two pages and distribute the first page to each student for individual reflection overnight (or over a weekend). The Guidesheet will help the students who are having trouble getting started, but you may want to use it later to guide a class discussion.

Your students' challenge is to determine which digit is represented by each letter in the puzzle. Tell students they should use the problems to establish the identity of a digit (with a certain letter) and then place that digit over the corresponding letter in all other locations on the sheet. Explain to your students that they can examine the problems in any order. Before your next class meeting, make transparencies of the pages and use them to demonstrate to the class how to identify which digit is under each card. Use the Guidesheet to facilitate your instructional process.

Challenge your students to modify this activity to make other examples to use with the class at a later date.

Find My Word I

In the following problems, letters have been substituted for the correct digits. Look for recognizable patterns that will help you determine which digit each letter represents. To begin, use a trial and error approach to decide which digit a particular letter represents. Each letter stands for the same digit in every place that it occurs. Put the letters over their corresponding digits to find the mystery word.

0	1	2	3	4	5	6	7	8	9

$$\begin{array}{r} HNKO \\ +\quad CI \\ \hline HNCP \end{array}$$

IT x IT = IHH

II x II = ITI

$$\begin{array}{r} IHH \\ -\quad IC \\ \hline ICI \end{array}$$

$$\begin{array}{r} NTON \\ -\ ENMO \\ \hline NKO \end{array}$$

NT x IK = NTK

EN ÷ M = O

$$\begin{array}{r} HNTO \\ -\ HIIE \\ \hline EIC \end{array}$$

$$\begin{array}{rl} & TIEE \\ H & \overline{)ONTC} \\ & \underline{O} \\ & \;N \\ & \;\underline{H} \\ & \;\;TT \\ & \;\;\underline{TK} \\ & \;\;\;TC \\ & \;\;\;\underline{TK} \\ & \;\;\;\;C \end{array}$$

Find My Word I Guidesheet

To solve this problem, you must look for recognizable number combinations that have been disguised by their representation with letters. Examine the operations in any order that you wish.

1. II x II = ITI *(means only 11 or 22 possible since 3 digit product)*

2. II x II = ITI *(means only 11 possible since 22 x 22=484)*

3. II x II = ITI *(means I = 1 and T = 2 since 11 x 11=121)*

4. IT x IT = IHH *(means H= 4 since 12 x 12 =144)*

5. NT x IK = NTK *(means K= 0 since I = 1 and 10 x NT = NT 0)*

6.
$$\begin{array}{r} \text{IHH} \\ -\underline{\text{IC}} \\ \text{ICI} \end{array}$$
(means C= 3 since I = 1 and H = 4)

7. ONTC ÷ H = TIEE *(means O = 8 since T= 2, H = 4 and 2 x 4 = 8)*

K	I	T	C	H				O	
0	1	2	3	4	5	6	7	8	9

Find My Word II Instructions

The next two pages contain one last activity designed to provide students with practice in logical thinking. For this activity, I recommend that you photocopy the two pages and distribute the first page to each student for individual reflection overnight (or over the weekend). The Guidesheet will help the students who are having trouble getting started, but you may want to use it later to guide a class discussion.

Your students' challenge is to determine which digit is represented by each letter in the puzzle. Tell students they should use the problems to establish the identity of a digit (with a certain letter) and then place that digit over the corresponding letter in all other locations on the sheet. Explain to your students that they can examine the problems in any order. Before your next class meeting, make transparencies of the pages and use them to demonstrate to the class how to identify which digit is under each card. Use the guidesheet to facilitate your instructional process.

Challenge your students to modify this activity to make other examples to use with the class at a later date.

Find My Word II

In the following problems, letters have been substituted for the correct digits. Look for recognizable patterns that will help you determine which digit each letter represents. To begin, use a trial and error approach to decide which digit a particular letter represents. Each letter stands for the same digit in every place that it occurs. Again, place the letters over their corresponding digits to find another mystery word.

0	1	2	3	4	5	6	7	8	9

$$\begin{array}{r} \mathrm{CW} \\ +\ \mathrm{OS} \\ \hline \mathrm{ES} \end{array}$$

$$\begin{array}{r} \mathrm{CP} \\ \times\ \mathrm{OW} \\ \hline \mathrm{CPW} \end{array}$$

$$\begin{array}{r|l} & \mathrm{K} \\ \hline \mathrm{C} & \mathrm{RO} \\ & \underline{\mathrm{RO}} \\ & \mathrm{W} \end{array}$$

$$\mathrm{R} \times \mathrm{R} = \mathrm{R} + \mathrm{R}$$

$$\begin{array}{r} \mathrm{ACL} \\ -\ \mathrm{SO} \\ \hline \mathrm{LEP} \end{array}$$

$$\begin{array}{r} \mathrm{ROSK} \\ +\ \mathrm{CLOW} \\ \hline \mathrm{SCWK} \end{array}$$

$$\begin{array}{r} \mathrm{PKSR} \\ +\ \mathrm{CSR} \\ \hline \mathrm{LOEP} \end{array}$$

$$\begin{array}{r} \mathrm{CSR} \\ -\ \mathrm{ORR} \\ \hline \mathrm{ACW} \end{array}$$

Find My Word II Guidesheet

To solve this problem, you must look for recognizable number combinations that have been disguised by their representation with letters. Examine the operations in any order that you wish.

1. R x R = R + R *(means R = 2 since it's the only digit that works)*

2.
```
   PKSR
 +  CSR
   ----
   LOEP
```
(means P= 4 since R = 2 and 2 + 2 = 4)

3.
```
   CW
 + OS
   --
   ES
```
(means W= 0 since W + S = S)

4. CP X OW = CPW *(means O = 1 since W= 0 and CP x O = CP)*

5.
```
   ACL
 -  SO
   ---
   LEP
```
(means L= 5 since O = 1, P = 4 and 5 – 1 = 4)

W	O	R		P	L				
0	1	2	3	4	5	6	7	8	9

Cooperative Chaos Instructions

The next two pages contain a much more interesting and difficult example of an activity that lends itself to the use of a memory chart. For this activity, make one photocopy of the next page for each six students in your class and then cut the 6 cells (lettered A through F) into individual cards. Make a photocopy of the second page to distribute to each of your students. Next, arrange your class into groups of six. Tell the class that this is a cooperative group problem-solving activity in which they can share the information on their cards by reading it aloud, but not by passing the cards to anyone else. After you have given a different card to each group member, then tell the students to read their cards, identify what problem they are trying to solve, and then solve the problem as a group.

Briefly remind them that the memory chart will prove useful by helping them keep track of the information provided in the clues. When you debrief the students, make a transparency of the second page and use it to demonstrate to the class how to use the chart to handle the information presented on the first page.

Challenge your students to modify this activity to create other examples that require the use of a memory chart, to use with their classmates at a later date.

Cooperative Chaos

You can tell your group what is on this card, but you can't pass it around for others to read.	You can tell your group what is on this card, but you can't pass it around for others to read.
The Dinosaurs had Tom for teacher during the third period. Dick had taught at Chaos the longest. During the first period, the team leader taught Harry's favorite group. A	The Team Leader had been at Chaos School for 5 years, which was less time than the other team members. Bombers were Tom's favorites, but he worried about them settling down. Dick's favorite group was the Champs. D
You can tell your group what is on this card, but you can't pass it around for others to read.	You can tell your group what is on this card, but you can't pass it around for others to read.
All teachers taught at the same time & swapped groups after each period. Sybil taught the Champs 3rd period. Each teacher taught every group during the first four periods. B	The Team Leader taught the Dinosaurs during the second period. Harry taught Bombers 3rd period. Sybil had been at Chaos School a shorter time than any other teacher. E
You can tell your group what is on this card, but you can't pass it around for others to read.	You can tell your group what is on this card, but you can't pass it around for others to read.
Chaos School has four teachers and four student instructional groups. Sybil was the Team Leader. Each teacher had a different favorite group and each taught that favorite group during 2nd period. C	You have all the information needed to find the only correct answer to the following question. NB: Some of the information is irrelevant. IN WHAT ORDER DID THE APES HAVE THE VARIOUS TEACHERS DURING THE FIRST FOUR PERIODS? F

Cooperative Chaos Memory Chart

	DICK	HARRY	SYBIL	TOM
FIRST				
SECOND				
THIRD				
FOURTH				

Apes' Schedule

1st Period ______________________________

2nd Period ______________________________

3rd Period ______________________________

4th Period ______________________________

A Non-Vulcan Mind Meld Instructions

The next page contains an activity that lends itself to divergent thinking. For this activity, make one photocopy of the next page for each student in your class. Distribute the page to your class before a long weekend or a break period (e.g. Winter or Spring). Tell the class that this is a problem-solving activity for which they must determine the relationship between the numbers and the abbreviations in the set of equations listed on the page.

Get the students started by solving several of the examples such as the 26 Letters of the Alphabet and Seven Wonders of the Ancient World, before they leave. Encourage them to make this activity a family problem-solving experience by asking their parents and siblings to discuss possible answers. Also suggest that there is probably more than one correct response for many of the equations.

When you discuss the activity with your students (after the weekend or break), make a transparency of the page and use it to list the answers your students suggest for each equation. Challenge your students to modify this activity to create other equations to use with their classmates at a later date.

A Non-Vulcan Mind Meld

Each of the equations below contains the initials of words that will finish the statement correctly. *Ergo,* 26 = Letters of the Alphabet. Try the others.

A. 26 = L. of the A. ______________________________
B. 7 = W. of the A. W. ______________________________
C. 1001 = A. N. ______________________________
D. 12 = S. of the Z. ______________________________
E. 54 = C. in a D. (with J.) ______________________________
F. 9 = P. in the S. S. ______________________________
G. 88 = P. K. ______________________________
H. 13 = S. on the A. F. ______________________________
I. 32 = D. F. at which W. F. ______________________________
J. 18 = H. on a G. C. ______________________________
K. 90 = D. in a R. A. ______________________________
L. 200 = D. for P. G. in M. ______________________________
M. 3 = B. M. (S. H. T. R.) ______________________________
N. 24 = H. in a D. ______________________________
O. 1 = W. on a U. ______________________________
P. 5 = D. in a Z. C. ______________________________
Q. 57 = H. V. ______________________________
R. 11 = P. on a F. T. ______________________________
S. 1,000 = W. that a P. is W ______________________________
T. 29 = D. in F. in a L. Y. ______________________________
U. 300 = P. in a P. G. in B. ______________________________
V. 40 = D. and N. of the G. F. ______________________________
W. 87 = F. S. and 7 Y. A. ______________________________
X. 360 = D. in a C. ______________________________
Y. 1,000 = Y. in a M. ______________________________
Z. 6 = F. on a C. ______________________________

Section 4

On-Computer Problem-Solving Activities

Chapter 9.
Public Domain Software Activities

On-computer activities generally require one or more class periods, depending on the activity's purpose and the instructional approach you adopt. If you use a single computer attached to a liquid crystal display (LCD) panel on an overhead projector, many of the activities described in this section could take place in a much briefer time period (probably 15 to 20 minutes). The key understanding with activities that make use of hands-on computer experiences (and most other instructional experiences) is that the value of the experience depends on carefully considered and planned pre- and post-computer activities.

The activities described during this section are all available on the Apple II platform that is still the most widely available computer in our schools. However, the programs used in the activities also exist in very similar forms for other computer platforms such as Macintosh, IBM-compatible computers, and even Commodore. Several of these on-computer activities (*Bagels, Hurkle Game, Division,* and *Tower*) make use of programs contained on a public domain software disk (with programs that can legally be copied and provided to your students and colleagues), available for a nominal fee from the International Society for Technology in Education. (See the About This Book page at the front of this book for information on purchasing the Apple disk from ISTE.) Other activities are designed to work with commercially available software from Sunburst or Tom Snyder Productions (*Muppetville, Mystery of the Hotel Victoria, Puzzle Tanks, The Factory, How the West Was 1 + 3 x 4, King's Rules, Word-A-Mation,* and *Animal Trackers*). The final set of activities are designed to take advantage of the features of integrated software such as *Microsoft Works, ClarisWorks, or AppleWorks*.

The manner in which you use the activities will naturally influence the amount of time that they take in any class. For the most part, the activities are designed to last one or more 45-minute class periods. The activities may need to be modified (perhaps simplified) depending on the ages, ability levels, and backgrounds of your students. Many of the programs have a mathematics orientation (e.g. *King's Rules, How the West Was 1 + 3 x 4, Puzzle Tanks,* and *The Factory*), but some (e.g. *Animal Trackers)* fit into a science curriculum; others (e.g. *Word-A-Mation)* emphasize language arts skills, and still others (e.g. *Muppetville* and *Mystery of the Hotel Victoria*) are more interdisciplinary in nature, involving language arts and mathematics within the problem-solving experience.

On-Computer Activities

Caution to Teachers

Don't use computers simply because you can—use them for a purpose. Ask yourself, "What can computers help me do better with them than I can do without them?"

How can Computers help with Problem Solving?

- **They can create teachable moments.**
- **They can present novel, controllable "microworlds."**
- **They can open windows to students' minds.**
- **They can provide students with interactive experiences.**
- **They can provide students with individual experiences.**
- **They can provide students with immediate feedback.**
- **They can be FUN!!**

Public Domain Software

Program Name	Problem-Solving Skills Reinforced
Bagels	This simple game encourages a systematic approach to problem solving. With a two-digit number, the game is quite simple. With a four-digit number, it's much more complex. To use the program, type RUN BAGELS.
Crypto	This program provides practice in pattern recognition by generating cryptograms to solve. Students can make messages on specified content for partners to decode, or they can solve the computer's own codes. To use the program, type RUN CRYPTO.

Division	This program encourages numerical pattern recognition by providing division calculations to any specified number of decimal digits. To use the program, type RUN DIVISION.
Hurkle Game	This game encourages a systematic approach to problem solving and introduces learners to the coordinate system. To use the program, type RUN HURKLE GAME.
Equations	This program encourages a systematic approach to solving equations by providing students with linear equations to solve. To use the program, type RUN EQUATIONS.
Othello	This more complex game encourages pattern recognition and a systematic approach to problem solving. To use the program, type RUN OTHELLO.
Towers	This program is modeled on the Towers of Hanoi puzzle. The game encourages working backwards and abstract thinking. To use the program, type RUN TOWERS.

Hurkle Game Guidesheet

The "Hurkle" is hiding somewhere on a 10 by 10 number plane. Your task is to find it in the fewest number of guesses. When you make a guess, the program provides clues to the location of the Hurkle based on map directions (e.g. "Go Southwest" or "Go North"). You must enter an ordered pair of numbers separated by a comma—the first number represents the distance across, the second number represents the distance up (e.g. the ordered pair 8,4 is located 8 dots over and 4 dots up).

Use this grid to help you keep track of your guesses and the clues you are given.

Your Guess	**The Screen Directions**
_____, _____	Go ____________________
_____, _____	Go ____________________
_____, _____	Go ____________________
_____, _____	Go ____________________
_____, _____	Go ____________________
_____, _____	Go ____________________
_____, _____	Go ____________________

Hurkle's Location ______________________________________

Sample *Bagels* (Two-Digit) Guidesheet

You are provided three clues to the identity of the mystery number:

- **PICO = One correct digit in the wrong location.**
- **FERMI = One correct digit in the right location**
- **BAGELS = None of the digits are correct.**

Use these numbers to keep track of your progress toward identifying the number.

0	1	2	3	4	5	6	7	8	9

Your Guess	**The Screen Response**
____ ____	____, ____
____ ____	____, ____
____ ____	____, ____
____ ____	____, ____
____ ____	____, ____
____ ____	____, ____

The Final Number ______________________________

Sample *Bagels* (Four-Digit) Guidesheet

Use these numbers to keep track of your progress toward identifying the number.

0 1 2 3 4 5 6 7 8 9

Your Guess	The Screen Response
____ ____ ____ ____	____/____/____/____
____ ____ ____ ____	____/____/____/____
____ ____ ____ ____	____/____/____/____
____ ____ ____ ____	____/____/____/____
____ ____ ____ ____	____/____/____/____
____ ____ ____ ____	____/____/____/____
____ ____ ____ ____	____/____/____/____
____ ____ ____ ____	____/____/____/____
____ ____ ____ ____	____/____/____/____
____ ____ ____ ____	____/____/____/____
____ ____ ____ ____	____/____/____/____
____ ____ ____ ____	____/____/____/____
____ ____ ____ ____	____/____/____/____
____ ____ ____ ____	____/____/____/____
____ ____ ____ ____	____/____/____/____
____ ____ ____ ____	____/____/____/____

The Final Number ______________________________

Sample *Division* Guidesheet

The program asks you to enter a number to serve as the numerator, then to enter a second number as the denominator. The program next asks you how many digits you wish to have displayed after it divides the numerator by the denominator. The result of the division is displayed to whatever number of digits you request.

The program is useful to help students examine patterns with repeating decimals. They can focus on discovering the patterns instead of concentrating on the division process.

Have students try several of the following examples and then let them explore numbers of their own selection to discover new patterns.

Numerator	Denominator	Decimals	Result
1	3	3	0.333
3	4	4	0.7500
3	8	5	0.37500
5	12	5	
4	7	12	
5	14	13	
5	21	??	
17	81	??	

Sample *Towers* Guidesheet

Your task in this computerized version of the "Towers of Hanoi Puzzle" is to move the 8 disks from Post #1 to Post #2. The complicating feature is that you can only move one disk at a time and cannot place a larger disk on top of a smaller one. Be warned: this is not an easy problem! The first few moves are quite easy, but the situation gets more complex very quickly. For your first move, you must move a disk from Post #1 to either Post #2 or #3. For the next move, you place the second smallest disk on whichever post you didn't use with the first move.

Below are the first few moves in solving the puzzle. Try to complete it on your own. Look for patterns as you move the disks from one post to another. For instance, when you move the top disk on an even numbered stack of disks (i.e. a stack of two, four, or six disks), place it away from the "target" disk. When you move the top disk on an odd numbered stack of disks (i.e. a stack of three, five, or seven disks), put it on the "target" disk. Good Luck!

Move #	Procedure
1	Put disk from Post #1 on Post #3.
2	Put disk from Post #1 on Post #2.
3	Put disk from Post #3 on Post #2.
4	Put disk from Post #1 on Post #3.
5	Put disk from Post #2 on Post #1.
6	Put disk from Post #2 on Post #3.
7	Put disk from Post #1 on Post #3.
8	Put disk from Post #1 on Post #2.
9	????????
10	????????

Muppetville Information Sheet

Program Description

Sunburst's *Muppetville* is designed to provide very young children with practice in pattern recognition and attribute recognition. Students use Kermit the Frog to select among six activities. Each activity provides engaging, colorful activities which encourage problem-solving skill development. Students can also use either a Touch Window or Muppet Keyboard instead of the standard keyboard.

Pre-Computer Suggestions

- Have students practice pattern recognition using manipulatives such as buttons or toothpicks. Create a pattern using the board or an overhead projector and challenge students to recreate the pattern at their desks.
- Have each student use Attribute Blocks at their desks and re-create arrangements of the Blocks that you make with the overhead projector. Ask students to describe what attributes each arrangement of blocks you create represents.
- Similar to the above suggestion, have a student volunteer take your place as the group facilitator. Ask the other students to explain the attributes of the arrangement of blocks that the student volunteer creates for the class to replicate.
- Use an overhead projector and a liquid crystal display device attached to a computer (or a large monitor) to introduce the program to the entire class and explain what each activity entails.

On-Computer Suggestions

- Use the Teacher's menu to customize the activities so that they are most appropriate for the ability levels of your students.
- Have students work with partners, take turns, and discuss each activity.

Mystery of the Hotel Victoria Information Sheet

Program Description

Tom Snyder Production's *The Mystery of the Hotel Victoria* is designed to provide practice in organizing information, reasoning deductively, examining assumptions, and solving mathematical word problems. As students use the arrow keys to move throughout the Hotel Victoria, they encounter employees and guests who offer them information about the mystery, in return for help in solving math word problems. An on-screen notebook provides students with a problem-solving assistant; they need only identify the important information and set up the problem correctly, then the program will complete the computations for them. They must keep track of the clues they gather.

Pre-Computer Suggestions

- Introduce your students to the systematic approach for solving math word problems that they will practice in *Hotel Victoria* using word problems presented to the class on an overhead projector.
- Use an overhead projector and a liquid crystal display device attached to a computer (or a large monitor) to introduce the program to the class and explain how to move through the hotel. Demonstrate use of the notebook and make copies of the hotel floor plans included in the program's documentation. Also make copies of the student data disk (Side B) so that each of your students has his/her own data disk.
- Use programs like *Where in the World is Carmen Sandiego?* or *Solve It* to introduce your students to mysteries and provide them with the necessary practice to improve the note-taking and organization skills they'll need to solve the Hotel Victoria mystery.

Puzzle Tanks Information Sheet

Program Description

Sunburst's *Puzzle Tanks* is designed to provide practice in generating multiple solutions, recognizing impossible problems, modularizing problems, and recognizing patterns. Students have several levels of difficulty from which to select problems dealing with liquid measures. The problems involve the use of two containers with different capacities and a storage tank (at the easier levels of difficulty). Students are challenged to produce a given amount of liquid using only the available containers and whatever repeated fillings and emptyings are necessary to achieve the required amount.

Pre-Computer Suggestions

- Have students use different sized containers and buckets of water to complete activity card requests individually, with partners, or in cooperative learning groups. The activity can be a whole class activity conducted outside in nice weather or part of a station approach where groups rotate to the sink or other appropriate areas of the classroom.
- Use an overhead projector or the board to provide the class with *Puzzle Tank* problem situations and have the class solve them individually or in pairs. Ask for volunteers to describe their procedures for achieving the requested amount. Encourage alternative solutions to the puzzles.
- Use an overhead projector and a liquid crystal display device attached to a computer (or a large monitor) to introduce the program to the class and explain how to use it. Demonstrate the procedures for solving the puzzles at the different levels.

On-Computer Suggestions

- Arrange students in pairs or cooperative learning groups to solve the puzzles, starting at the easiest levels. As they succeed at the easy levels, challenge them to attempt the more difficult levels.
- Have all students solve the puzzles at the level of difficulty at which they feel most comfortable. Challenge them to attempt more difficult levels occasionally.

The Factory Information Sheet

Program Description

Sunburst's *The Factory* is designed to provide practice in sequencing, working backwards, and spatial perception. Students use three machines—a puncher, a striper, and a rotator—to create products on a white square shown on-screen. They have the option to make a product and challenge a partner to re-create it, or to make an easy, medium, or difficult computer-generated product.

Pre-Computer Suggestions

- Have students play the role of the various machines in a whole-class exercise. One student has a hand punch, another a marker, a third a protractor (or marked paper) for determining degree rotations, a fourth carries the product from machine to machine. The rest of the class agrees on an arrangement of the machines (students) and then predicts the appearance of the final product by drawing the anticipated outcome on paper at their desks.
- Similar to the above activity, group students in teams of four or five. Have each team arrange themselves (the machines) in different order and predict the appearance of the product by drawing the anticipated outcome on paper at their desks before they produce it as a group.
- Have a student arrange a series of 4 or 5 machines by drawing them on the board or overhead projector. The rest of the class then predicts the product by drawing it on paper at their desks.
- Use an overhead projector and a liquid crystal display device attached to a computer (or a large monitor) to introduce *The Factory* to the class and explain how to use the program.

On-Computer Suggestions

- Arrange students in pairs and have each individual design a product using a specified number of machines. When the product is done, have students exchange computers and reproduce their partner's product.
- Have all students create computer-generated products at the level at which they feel most comfortable (easy, medium, or difficult).

How the West Was 1 + 3 x 4 Information Sheet

Program Description

Sunburst's *How the West Was 1 + 3 x 4* is designed to provide practice in sequencing, working backwards, and order of operations. Students operate with three randomly generated digits to produce the optimal answer that will propel their stage coach or locomotive across a game board. The digits can be added, subtracted, multiplied, or divided to produce the best result. Students have an option to play against a friend or the computer.

Pre-Computer Suggestions

- Introduce your students to the principles of the order of precedence operations that they'll practice in *How the West Was...* using a series of different examples presented to the class on an overhead projector.
- Have students role play a version of *How the West Was...* in a whole class exercise. One student represents the stage coach, another the locomotive, and five others represent towns along the trail (a number line marked using chalk or tape), while three students will operate the spinners. The rest of the class forms into two teams—one team controls the stage coach and the other team controls the locomotive.
- Use an overhead projector and a liquid crystal display device attached to a computer (or a large monitor) to introduce your class to the program and demonstrate how to use it.

On-Computer Suggestions

- Arrange students in pairs and have each dyad use *How the West Was...* by playing either against each other or with each other against the computer.
- Have students use *How the West Was...* individually by playing against the computer. When the two activities are completed, ask the class to discuss which approach (individually or in pairs) they preferred and why.

King's Rules Information Sheet

Program Description

Sunburst's *The King's Rules* is designed to provide practice in sequencing, working backwards, and looking for patterns. Students determine the pattern associating the three numbers provided in each exercise. Students have the option to test their understanding of the pattern's rule by providing three numbers of their own and stating whether the numbers follow the same rule or not. After they identify several rules, they advance to higher levels of difficulty.

Pre-Computer Suggestions

- Introduce your students to the techniques that they will practice in *TheKing's Rules* using a series of different examples presented to the class on an overhead projector. Discuss strategies for determining the rules involved with each set of numbers and ask for students to volunteer their successful approaches.
- Use an overhead projector and a liquid crystal display device attached to a computer (or a large monitor) to introduce your class to *The King's Rules* and demonstrate how to use it at the various levels of difficulty.

On-Computer Suggestions

- Arrange students in pairs and have each team use *The King's Rules* as a cooperative team. After each session, ask all the teams to share their experiences in a whole-class debriefing period.
- Have students use *The King's Rules* completely on their own. When the two activities are completed, ask the class to discuss which approach (individually or in pairs) they liked better and why they preferred that approach.

Word-A-Mation Information Sheet

Program Description

Sunburst's *Word-A-Mation* is designed to provide practice in scanning for clues, working backwards, and estimating, predicting, and projecting. Students are asked to complete word chains comprised of a series of words. Each word in the chain is related to the following word by some association, including antonyms, synonyms, homophones, and past tenses. Students can determine how many of the words between the first and last are revealed. The fewer words revealed, the more difficult the activity. At higher levels, new associations such as "category" (for instance) can link words in chains together.

Pre-Computer Suggestions

- Introduce your students to the word associations they will practice in *Word-A-Mation* using a series of different examples presented to the class on an overhead projector. For each example, ask students to explain the relationship existing among the words in the chain.
- Group your students into two teams to examine the word associations they will practice in *Word-A-Mation*. Present examples to the class on an overhead projector and ask representatives from each team to identify the association connecting the words in the chain, as a cooperative or competitive activity.
- Use an overhead projector and a liquid crystal display device attached to a computer (or a large monitor) to introduce *Word-A-Mation* to your class and to demonstrate how to use it.

On-Computer Suggestions

- Arrange students in pairs and have each dyad use *Word-A-Mation* as a team to solve the word chains that the computer provides.
- Have students use *Word-A-Mation* individually by playing against the computer. When the two sessions are completed, ask the class to discuss which approach (individually or in pairs) they preferred and why they liked that approach better.

Animal Trackers Information Sheet

Program Description

Sunburst's *Animal Trackers* is designed to provide practice in recognizing patterns, analyzing data, and organizing information. Students track animals in their natural ("microcomputerized-natural") habitats and seek to identify the animal by using an on-screen field guide and notepad. Students have the option to determine the level of difficulty of the search —from Novice to Expert.

Pre-Computer Suggestions

- Introduce your students to the animal habitat characteristics that they will practice in *Animal Trackers* using examples drawn from textual readings or presented to the class on an overhead projector.
- Use an overhead projector and a liquid crystal display device attached to a computer (or a large monitor) to introduce your class to *Animal Trackers* and to demonstrate to them how to use it.

On-Computer Suggestions

- Arrange students in pairs and have each team use *Animal Trackers* play as a team to track the randomly-generated animal that the computer provides.
- Have students use *Animal Trackers* individually to tracking the animal. When the two sessions are completed, ask the class to discuss which approach (individually or with a partner) they preferred and why they liked that approach better.

Chapter 10.
Integrated Software Activity Ideas

Overview

Teachers often ask me, "How can I use a spreadsheet with my students?" or "Do you have any ideas about how to use databases to help my students improve their problem-solving skills?" Now that computers have been available in schools and homes for many years, a large number of teachers have become skilled users of integrated programs like *Microsoft Works*, *ClarisWorks*, or *AppleWorks*. These teachers use their software to complete tasks associated with their profession. They word process their lesson plans and other professional writing; they use databases to organize their student records and spreadsheets to calculate their grades and budgets; they print-merge documents to personalize their communication with parents. These teachers successfully use the computer as a productivity-enhancing tool to improve their total professional performance.

Such skills certainly empower teachers by removing some of the drudgery associated with their professional tasks. However, they don't necessarily improve a teacher's most important role—enhancing the learning process. Nevertheless, once teachers are competent "productivity tool" users, they frequently search for ways to use these same computer capabilities to enhance their classroom instruction. Unfortunately, practical strategies for integrating computer use into the instructional process can prove difficult to discover or create without the presence of experienced mentors. This section of the text is written to assist teachers in their search to extend productivity skills to classroom instruction with a problem-solving focus.

Some of the activities presented here can be used effectively with a single computer in the classroom, while others are more appropriately used in a computer lab. Most of the strategies can be enhanced with the use of a large monitor or an LCD (liquid crystal display) and an overhead projector so the computer display can be read easily by the whole class. However, the activities can all be modified to suit the instructional style of the teacher, the available equipment, the grade level of the students, and the objectives of the lesson.

These suggestions are excerpted from my texts, *Microsoft Works for Educators* (IBM-compatible or Macintosh computers). Individuals interested in obtaining either version of the text should contact the Wadsworth Publishing Company by calling (800) 227-8354, extension 6. To simplify the text, I have referred to the integrated package as "*Works*" throughout the article. Although these strategies are written for *Microsoft Works*, they can, for the most part, be easily modified for use with other popular integrated packages like *ClarisWorks* or *AppleWorks*.

Word Processing Activities

Re-sequencing a Set of Instructions

This is a good activity to introduce your students to the word processor's "cut and paste" commands while reinforcing their understanding of other content. First, you create a series of sequenced instructions, such as the procedures to use when checking a book out of the library, or the process to follow when preparing a research paper, or the steps to follow when conducting a particular science experiment. The instructions you choose should reference a topic with which you expect the students to be familiar already. This exercise is designed to reinforce, not introduce, a topic.

Next, create a word-processed document with the set of instructions listed out of sequence. Introduce the students to the use of "cut and paste" commands to move the instructions from one location to another. Use several sets of out-of-order instructions to demonstrate the rearranging process for the whole class (use paper and pencil activities if a large monitor or an LCD with an overhead projector is not available).

When the students understand the necessary procedures, have them use the computer(s) independently, printing out the completed exercise or saving it on disk using a new file name. The exercises can be corrected by students in pairs to check if their lists are identical. Additional instructional ideas include the steps to use when solving a math word problem, adding two numbers, going from school to the library, reading chapters in science or social studies texts, dividing three-digit numbers by one-digit numbers, or beginning and ending the school day.

Guiding Brainstorming Sessions

Word processing can be used effectively to guide your students through brainstorming sessions in which the class is charged with supplying as many ideas relating to a topic as they can in a given period of time. The situation discussed in the previous section is an example of a brainstorming session; it establishes agreed-upon rules for revision sessions. Typically, the teacher's role in guiding brainstorming sessions is to record students' suggestions on the blackboard. When the time allotted for brainstorming ideas has expired, the class reviews the listed suggestions and determines which of them are most important, perhaps prioritizing or sequencing them in order of importance or interest.

How can a word processor assist in this procedure? A brainstorming session must be quick-paced or students' enthusiasm for suggesting ideas quickly fades. By running the word processor in a computer connected to a large monitor or LCD, the teacher (or a student with keyboarding skills) can quickly enter student responses. The students can all see the responses displayed as quickly as they are made.

When the time comes to review and prioritize the suggestions, you can use the word processing features to facilitate and enhance the process. You can use cut-and-paste features to rearrange the ideas in order of importance. Next, you can use style features, such as boldface and larger character size, to accentuate important ideas. The spelling checker will eliminate any concern about misspellings. When the final list is ready, you can print out a polished version and make copies for all students several minutes after the brainstorming session ends.

Even if you don't have a large display device available, you can still use these procedures. When the word processed list is complete, quickly print out some draft copies of it and distribute the lists to small groups of students. The groups can discuss the relative importance of the different suggestions from the printouts. When the groups reach an agreement, you can create and print the final list so that everyone has a copy.

Creating Collaborative Stories

This suggestion provides students the opportunity to practice their word processing skills, their creative writing skills, and their group process skills. This activity is conducted most effectively in a computer lab. During the exercise, your students will create collaborative stories in cooperative groups. Give the students a topic to focus their writing and time to brainstorm appropriate story ideas, then ask each student to begin drafting a story on his/her computer.

After about fifteen minutes, tell the students to complete the sentence they are writing and then exchange computers with another student in their group. You should arrange the groups before the activity to insure that a cooperative experience will occur. Tell each student to read the story now displayed on his/her computer screen and then continue the story in the manner that he/she believes the story's author had intended.

After another fifteen minutes elapses, interrupt the students again, ask them to complete the sentence they are writing, and then exchange computers. Again, tell each student to read the story now displayed on his/her computer screen and then continue it in the manner that he/she believes the story's author had intended. After one final fifteen minute period, interrupt the students, ask them to complete the sentence they're writing, and return to their original computer. Ask them to read their stories in the modified form, use the spell checker to correct any misspellings, and then print them. The group stories can be posted on the bulletin board or used in class as an exercise to help students determine qualities of an author's voice.

Database Activities

Conducting Class Surveys

Surveys are good activities to introduce your students to the world of databases. Students usually find surveys interesting and motivating. Begin each school year by asking your students to complete surveys with questions on their "favorites" (foods, pastimes, colors, movies, singers, songs, sports, books, and subjects). The surveys should also include questions on their "least favorites" (sports, foods, songs, colors, movies, singers, and subjects). Additional survey questions can include names and ages of siblings, names and types of pets, personal motto, favorite quotations, bed time, hours slept per night, birth month and sign, musical instrument(s) played, parents' occupations, chores responsible for, and part-time jobs held.

After the students complete the surveys, create a database file containing the student information. The database field names will represent the survey questions: Favorite Food, Siblings, Chores, etc. After the database file is complete, use it to introduce your students to the database manager. Use a large monitor or an LCD with an overhead projector to guide your students through database manipulations such as sorting, searching, and changing the screen display from List View to Form View. Have students formulate search questions such as, "Which students list pizza as one of their favorite foods, have a pet dog, and are responsible for washing the dishes in their homes?" Then use database capabilities to display the answer for all students to see.

Once students understand the database capabilities, create a guide sheet with sample questions for students to answer independently with the database. The questions should be designed to provide students with practice using all capabilities the database offers. The students can use reporting features to print out the answers to the guide sheet questions. As students learn to use the powers of the database, they learn more about their classmates—often discovering they have more in common with other students than they had realized. In addition, the students are often more motivated to investigate information about their peers, initially, than they might be to examine information about more academic topics.

After your students have completed the guidesheet questions, ask them to formulate additional questions for their classmates to answer. This practice will encourage the students to explore the database file, even if the information about their peers is not motivating enough by itself. Have the database file available for students to use throughout the first part of the school year.

Creating Databases to Enhance Units of Study

Class projects and units of study provide an excellent vehicle for compiling instructional databases. All disciplines have a body of information that students must master. Part of this information is a collection of facts that you want students to learn and then use to recognize the trends and patterns characteristic of the discipline. In a study of the solar system, for instance, you might want students to recognize and explain the relationships that exist in the arrangement of the planets. This might include, for example, the concept that the more distant a planet is from the sun, the longer its "year." In other words, the time it takes a planet to rotate on its axes determines the length of the planet's "day." In a study of states of the United States, you might want students to recognize and explain patterns such as the states in the eastern part of the country generally gained statehood before those west of the Mississippi, or the fact that a state's population (and not its size) directly affects its number of representatives in Congress.

Units of study such as the solar system or the states of the United States are ideally suited to the use of databases. Often patterns are difficult to see when information is presented in a static form such as a table in a textbook. If the same information is available in a dynamic form such an electronic database file, the data can be manipulated so that the relationships are more discernible. Once your students are competent database users, they can use database powers to manipulate the information and discover the patterns or trends for themselves. This discovery experience often leads to a more lasting understanding than by your "telling" them the pattern and asking them to "learn" (or memorize) it.

The following activities can be implemented in many different ways. Commercial or teacher-made databases can be provided to students with guide questions for them to answer. As they manipulate the database files to answer your questions, students can identify the patterns or important concepts for themselves. This approach is probably the most effective one to adopt when you first start using databases instructionally.

A second, more powerful, approach involves having your students create actual database files with pre-determined fields. Using this approach, during your study of the solar system, assign groups of students to gather specific data on each planet and insert the information into an already created (blank) database form. One suggestion to encourage accuracy: have two groups (or individuals) responsible for separately gathering the data on each planet. Before the data are entered into the database file, have the two groups (or individuals) verify that their data are identical, resolving any inconsistencies before the information is entered. This approach can be used most effectively after your students have already had several opportunities to use databases.

In the third approach, your students will design and create the database files themselves. This method is particularly effective as a whole-class activity the first time, and later as a group activity. During your study of "The Age of Exploration," for example, ask students to design a database that would help them understand and interpret the information they are studying. After they design the database (determining the fields and the type of data to include), the students use appropriate resources to gather the necessary data, then enter it into the file. Later, they can share their database file with the class, demonstrating how it can be used to interpret information about exploration. This approach is recommended after your students have had considerable experience with databases. The instructional strategies can all be used in any discipline and at nearly any grade level. The following examples briefly suggest units of study that lend themselves to the instructional use of databases, but they are included only to start you thinking.

Solar System

Group your students into nine groups (with each group responsible for two planets) and distribute sheets with items representing the fields from a **Planets** database. The students' task is to use the (current) appropriate resources necessary to find the data they need to complete the database. Before they enter the information in the file, have representatives from the two groups responsible for each planet compare their findings to insure consistency. When the database file is complete, have the students look for patterns such as the relationship between a planet's distance from the sun and the length of its "year," the relationship between the time it takes a planet to rotate on its axis and the length of its "day," and the relationship between a planet's distance from the sun and its surface temperature.

States

Use the same procedures described above, but when the **States** database file is complete, ask the students to look for patterns such as the relationship between geographical location and the year statehood was achieved, the relationship between geographical location and population rank order (relatively), and the relationship between population and the number of representatives to the United Stated Congress.

Holidays

Again, use the procedures described above, but when the **Holidays** database file is complete, have students look for patterns such as the relationship between the type of holiday and its country of origin, the religious origin of the holiday, and the countries where it is currently observed.

Presidents

Use the same procedures, but when the **Presidents** database file is complete, have the students look for patterns such as the relationship between the state of birth and the president's political party and the relationship between presidential order and the state of birth.

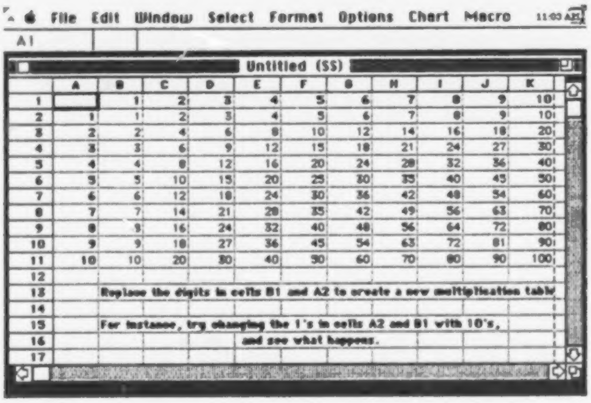
Related Suggestions

After your students have created their own database files, have them demonstrate the use of their files to other classes and grade levels familiar with the content of the database. After your students have created their own database files, have them generate sets of questions for their classmates to answer using the file. Rotate the groups so that they can explore the other databases and answer each others' questions. Save these database files and the sets of questions as valuable instructional resources for following years. Consider sharing the files with other teachers and placing a copy in the media center or library.

Spreadsheet Activities

Multiplication Table

Create a spreadsheet for your students that resembles a ten-by-ten multiplication table (see Figure 1). Place formulas in the cells in row 2 and then use the spreadsheet's copying powers to duplicate those formulas relative to their new positions in the cells from rows 3 through 11. With *Microsoft Works*, for instance, the formula in cell B2 is **=A2*B1** (which means multiply the number in cell A2 by the number in cell B1 and display the answer in this cell). Also with *Microsoft Works*, the formula in cell C1 is **=B1+1** and the formula in cell A3 is **=A2+1**.



	A	B	C	D	E	F	G	H	I	J	K
1		1	2	3	4	5	6	7	8	9	10
2	1	1	2	3	4	5	6	7	8	9	10
3	2	2	4	6	8	10	12	14	16	18	20
4	3	3	6	9	12	15	18	21	24	27	30
5	4	4	8	12	16	20	24	28	32	36	40
6	5	5	10	15	20	25	30	35	40	45	50
7	6	6	12	18	24	30	36	42	48	54	60
8	7	7	14	21	28	35	42	49	56	63	70
9	8	8	16	24	32	40	48	56	64	72	80
10	9	9	18	27	36	45	54	63	72	81	90
11	10	10	20	30	40	50	60	70	80	90	100
12											
13		Replace the digits in cells B1 and A2 to create a new multiplication tabl									
14											
15		For instance, try changing the 1's in cells A2 and B1 with 10's,									
16					and see what happens.						
17											

Figure 1

The instructions in the spreadsheet ask students to change the numbers to two cells—A2 and B1—the cells that determine the range of the multiplication factors. If students follow the instructions and replace the ones with tens, the multiplication table will display the products of the numbers between ten and twenty. Have your students experiment with other numbers, including decimals and integers. Explain that if they enter large numbers, the spreadsheet columns may not be wide enough to display them and they will see a string of "######" instead—the spreadsheet's way of telling them the resulting products are too large to display with the current column width. If they want to use large numbers, explain the procedure for increasing the column widths so they can verify the correct results.

After your students have explored the calculating powers of the spreadsheet for several minutes, have them inspect the cells containing formulas. Discuss the syntax of formulas—with *Works*, for instance, formulas must begin with an equal sign—and help them interpret the purpose of the different formulas. Also explain the difference between

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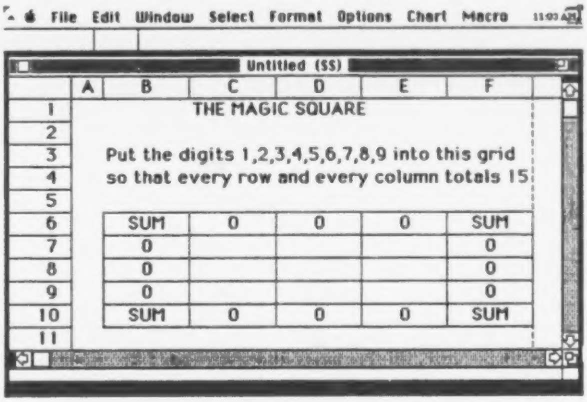
what is displayed on the screen in a cell—the value that the cell's formula produces—and the formula itself, which is visible on the display line of the active cell (the cell on which the cursor is positioned).

Magic Square

Create a spreadsheet for your students that resembles a magic square grid (see Figure 2). Notice two differences in the appearance of the spreadsheet: it is displayed in much larger characters (size 14) and the characteristic grid markings around each cell are not displayed (*AppleWorks* users will not be able to enlarge their screen display). These changes make the spreadsheet easier for younger students to read.



	A	B	C	D	E	F
1		THE MAGIC SQUARE				
2						
3		Put the digits 1,2,3,4,5,6,7,8,9 into this grid				
4		so that every row and every column totals 15				
5						
6		SUM	0	0	0	SUM
7		0				0
8		0				0
9		0				0
10		SUM	0	0	0	SUM
11						

Figure 2

Place formulas in the following cells: C6, D6, E6, B7, F7, B8, F8, B9, F9, C10, D10, and E10. Use your spreadsheet's copying powers to save you time. With *Works*, for instance, the formula in cells C6 and C10 is **=C7+C8+C9**; the formula in cells B7 and F7 is **=C7+D7+E7**. The instructions written on the spreadsheet ask students to enter the digits—1,2,3,4,5,6,7,8,9—into the magic square grid. The nine appropriate cells for entering digits are **C7**, **C8**, **C9**, **D7**, **D8**, **D9**, **E7**, **E8**, and **E9**. Challenge your students to use each of the digits only one time and still have all twelve **SUM** figures (actually, only six unique sums) equal fifteen. The problem can, of course, be solved.

Have your students experiment by trying numbers and inspecting the resulting sums. If someone finds a solution, verify that none of the digits has been used twice. Challenge your students to see if there is more than one possible solution to the puzzle. After they have explored the calculating powers of the spreadsheet for several minutes, have students inspect the cells containing formulas. Discuss the syntax of formulas and help them interpret the purpose of the different formulas. Reinforce the

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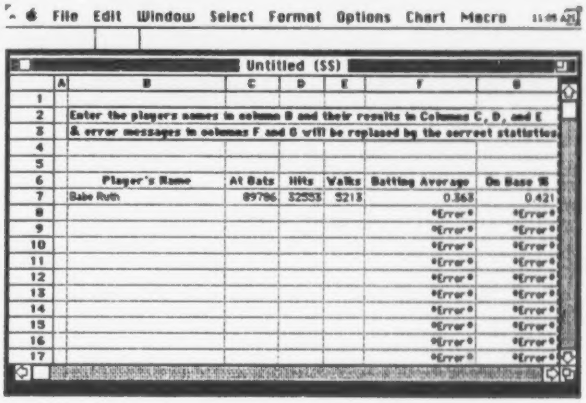
difference between what is displayed on the screen in a cell—the cell's value—and the formula itself, visible on the display line for the active cell.

Calculating Sports Statistics

Create a spreadsheet for your students that resembles a "sports stats sheet" (see Figure 3). The spreadsheet is a table designed to calculate baseball statistics, including batting average and on-base percentage. The instructions in the spreadsheet ask students to enter the names of players in column **B** and their results (that is, the players' times at bat, hits, and walks) in columns **C** through **E**. If students follow the instructions, the statistics table will display the batting averages and on-base percentages for any players they enter—themselves, friends, or their major league idols.



	A	B	C	D	E	F	G
1							
2		Enter the players names in column B and their results in Columns C, D, and E					
3		& error messages in columns F and G will be replaced by the correct statistics					
4							
5							
6		Player's Name	At Bats	Hits	Walks	Batting Average	On Base %
7		Babe Ruth	89786	32553	5213	0.363	0.421
8						*Error*	*Error*
9						*Error*	*Error*
10						*Error*	*Error*
11						*Error*	*Error*
12						*Error*	*Error*
13						*Error*	*Error*
14						*Error*	*Error*
15						*Error*	*Error*
16						*Error*	*Error*
17						*Error*	*Error*

Figure 3

Place formulas in the cells F7 and G7, then use the spreadsheet's copying powers to duplicate those formulas relative to their new positions down those two columns. With *Works*, the formula in cell F7 is **=D7/C7** (which means divide the number in cell D7 by the number in cell C7 and display the answer in this cell). Again with *Works*, the formula in cell G7 is **=(D7+E7)/C7**. Have your students enter as many players as they want. If necessary, show them how to copy the formulas down to additional cells if they enter more than 25 or 30 players. After they have explored the spreadsheet for several minutes, have them inspect the cells containing formulas. Again, discuss the syntax of the formulas and help them interpret the purpose of the different formulas.

Helping Students Manage Their Budgets

Young people (and many older people) are often not very good at managing whatever money they have available—whether from

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allowances or part-time jobs. This activity shows them how they can use spreadsheets to help them keep their finances sorted out. Begin with a brainstorming session to determine your students' most common sources of incomes and types of expenditure. Agree on some standard terminology, such as the category labels for expenditures, then create a blank budget file.

Alternatively, you could demonstrate to the students the process for inserting formulas into cells and have them design their own budget files. With either approach, have the students maintain the files throughout the year so they can observe their own spending patterns over time, calculate monthly averages, determine semi-annual figures, etc. In this way, you can demonstrate the use of financial modeling by asking "what if" questions, for example, if they decrease the money they spend on movies or increase what they spend on clothes, what will the result be on their overall financial state?

Helping Students Anticipate Their Grades

This activity helps students see the effect a test score may have on their class grade or the effect that the grade in a particular course may have on their cumulative grade point average. Demonstrate to the students the procedure for creating a new spreadsheet. Discuss the column headings and help them enter the appropriate formulas in the correct cells. (If you have a letter grading system, help them translate letter grades to numerical equivalents).

When students complete their spreadsheets, demonstrate the spreadsheet's modeling power by having the students enter their "worst case" grade predictions into the proper cells. When the grades are entered, ask them to determine the effect poor grades would have on their cumulative grade point average (GPA). Next have them change each grade to the score they believe they will earn, to see what GPA those grades produce. Students can use this tool to determine the effect of any one score or grade on their cumulative performance, perhaps mitigating any overly drastic reactions to one poor score, or any overly optimistic expectation attached to one good result.

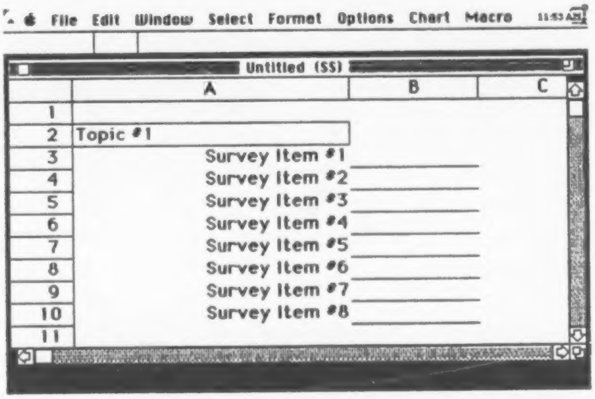
Charting Activities

Before you introduce your students to a charting program, have them complete graphing exercises without the benefit of a charting program. This experience will help them understand the advantages that a charting program can provide. These preparatory experiences will be more concrete, insuring that your students have a firm foundation in the procedures for graphing data. After these preliminary procedural experiences, the charting program's powers will let them concentrate on understanding graphing concepts instead of worrying about the straightness of their lines.

Introduce graphing to your students' by having them interpret graphs created by others, such as commercially available or teacher-prepared materials. Follow that experience with opportunities to interpret and discuss charts that you generate for them from surveys or other class projects. After this foundation, demonstrate the process for creating charts with computer software, have them design their own projects, and create charts to present to their classmates.

The Survey Charter

Create a spreadsheet file containing charting pre-designed specifications to simplify your students' introduction to chart procedures. Design the spreadsheet to include a simple tally sheet for recording and charting (in a pie or bar graph form) the results of any survey with eight or fewer categories (see Figure 4). When students use the spreadsheet, they first replace the on-screen labels (**Survey Item #1**, **Survey Item #2**, etc.) with their own survey categories by typing over the current labels. Next, they enter the numbers corresponding to each category in the column C cell to the right of the category label. Arrange the chart specifications so that your students can ignore any unused categories (i.e. they will not appear on the chart).



	A	B	C
1			
2	Topic #1		
3	Survey Item #1		
4	Survey Item #2		
5	Survey Item #3		
6	Survey Item #4		
7	Survey Item #5		
8	Survey Item #6		
9	Survey Item #7		
10	Survey Item #8		
11			

Figure 4

Once your students have seen the charting powers the integrated program provides, help them print the charts to include in reports or display on the bulletin board. Another idea is to ask each student to select a topic of interest and conduct a class survey on that topic. When the results have been gathered, have each student chart the graphs, print them, and display them on a bulletin board representing "A Profile of The Class."

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Challenge your students to conduct additional surveys using the same topics of interest from the previous charting project, but this time have them survey students from another class or grade level. After they gather and chart the results, display the graphs on a bulletin board so that each chart representing class preferences is adjacent to the corresponding chart from the other class or grade level. Use the charts to discuss similarities and differences existing between peers.

Encourage your students to survey their parents using the same topics used in the other survey projects. After they gather and chart the results, display the graphs on a bulletin board so that each chart representing class preferences is adjacent to the corresponding chart indicating their parents' responses. Use these charts to discuss the similarities and differences that exist between generations.

Graphing the Weather

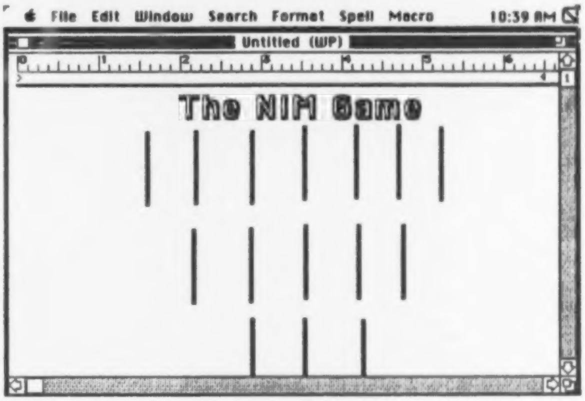
The weather is a topic that is ideally suited for graphing exercises. Weather happens every day, so the graphing exercises can be integrated into the science curriculum as an on-going project in which all students can take part. Charting the weather can also help students recognize and discover important weather-associated phenomena on their own, instead of trying to learn the information from a text. Once you have introduced your students to charting capabilities, they can assume the responsibility for maintaining accurate weather data on a daily, weekly, monthly, or seasonal basis.

Assign a rotating group of students to gather data on a daily basis, including the temperature reading at a set time in the morning and the afternoon, the rainfall for a 24-hour period, the barometric pressure at a set time in the morning and the afternoon, and possibly the wind velocity. These data can be recorded and maintained with paper and pencil, then charted (as line or bar charts) at periodic intervals appropriate to your instructional plans. Have students gather non-numerical weather data such as "predominate cloud type" or "general weather descriptors" (like "cloudy" or "fine") and use them to develop monthly pie or bar charts showing the most common weather patterns in your area. After students have gathered rainfall and barometer readings, have them use the data to develop a mixed bar/line chart. Challenge them to discover any relationships that may exist between barometric pressure changes and rainfall that can be detected through examining their charts. Assign students to develop a line chart that compares the average daily temperatures in your area with three other regions from around the world selected for climatic comparisons—e.g. Jarkarta, Indonesia; Yellow Knife, Canada; and Cape Town, South Africa.

Draw Module Activities

The NIM Game

Use your drawing program to create a file called The NIM Game that resembles Figure 5. Before your students use the file, briefly demonstrate and explain simple drawing concepts (such as selecting "objects," deleting selected objects, shift clicking to select multiple objects). After this brief introduction, introduce them to The NIM Game file—a simple version of the ancient game NIM. The game is played by two players who alternate turns, removing one, two, or three "sticks" (or lines) from the same row at a time. The object of the game is to force the opponent to remove the last stick—that is, each player wants to leave one stick on the screen when his/her turn is complete.



The NIM Game

Figure 5

When they finish a game, students should close the file without saving. To play again, all they have to do is open The NIM Game file. Have students play an opponent "best two out of three" games, then switch pairs so that students can face other opponents. After several rounds, ask students to explain the approaches they are using to win the game. In particular, ask the "winning" students to discuss their strategies. Students can "discover" some interesting math principles that if they look for patterns while they play this game. At the same time, they will gain experience in several fundamental draw program concepts.

You might want to introduce your students to the game using paper and pencil or chalkboard and chalk first, then let them use the computerized version. You could also establish a "NIM Challenge Tournament" in which you schedule your students to randomly assigned, single-elimination (or double-elimination) seedings. After the "championship rounds" are complete, have the tournament winners explain the winning

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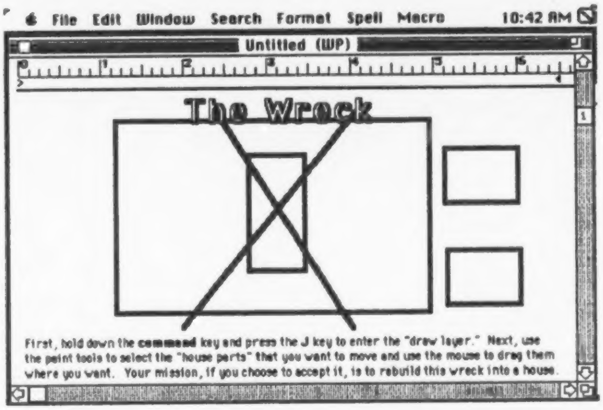
strategies to their classmates. Your students may want to challenge students in another class(es) or grade level to NIM Tournaments to see if the "winning strategies" used during the class tournament are successful with a broader competition.

The Wreck

Use your drawing program to create a file called The Wreck that resembles Figure 6. Before your students use the file, demonstrate and explain simple drawing concepts like selecting and dragging objects. After this brief introduction, introduce them to The Wreck file. The file contains a demolished version of a house shown in Figure 7.



First, hold down the **command** key and press the J key to enter the "draw layer." Next, use the paint tools to select the "house parts" that you want to move and use the mouse to drag them where you want. Your mission, if you choose to accept it, is to rebuild this wreck into a house.

Figure 6

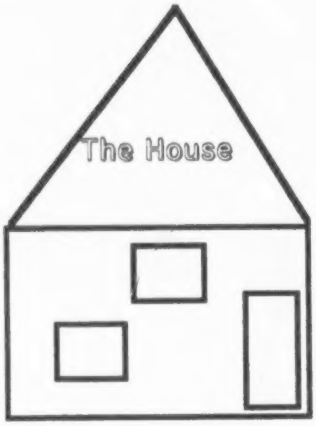


Figure 7

The objective of the activity is to reconstruct the dismantled house by rearranging the various objects on the screen to create a figure resembling

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a house. Students should select the house "parts" they want to move and use the mouse to drag them to a new location. You may want to challenge the students to use the objects provided in this drawing to create other pictures. Have your students see how many different designs are possible from the same pieces. After your students are proficient users of your draw program, have them create, print, and then save their pictures. Once the pictures are safely stored on disk, have them dismantle the pictures and then ask their friends or younger students to reassemble them, re-creating the final picture they have illustrated in the printed copy.

Telecommunications Activities

If you do not have the necessary communications hardware—that is, a modem connected to a standard telephone line—you will not be able to use these suggestions as actual telecommunications exercises. However, you can modify most of the activities to work without communications hardware. For instance, your students can complete the projects with the computer using normal procedures. Instead of telecommunicating the completed work using a modem, they can "telecommunicate" it by mail. The projects will suffer the loss of immediate response time provided by telecommunicating with a modem, but they will still prove successful.

Expenses for telecommunications activities can be problematic, so you may want to begin your explorations of telecommunications with simple projects. Activities linking your class with another class of the same grade level in a distant site are especially effective. For instance, if you teach in an urban setting, connecting with a class from a rural community can offer students interesting contrasts in lifestyles and experiences. The physical distance separating the two classes is less an important consideration than the matching of the two classes for the purpose of comparison.

"Global Classroom" Projects

The "Global Classroom" is an excellent first project to introduce communications linkages between students in your class and students at a distant site. Many educational researchers have observed that our students do not have an awareness of the world outside of their own immediate environment—home, classroom, community. This activity introduces students to others of their age from different locations, backgrounds, and even nationalities. By establishing this linkage, you open the world to your students, encouraging them to understand themselves more completely by reflecting on the ways in which they are similar to other students their age and on the ways in which their experiences are unique.

To make this activity most meaningful, you should try to establish personal contact with the teacher of the cooperating class before you undertake projects of this type. Meeting together and discussing the objectives of the project is a key to success. If you cannot meet face-to-face, using telephone or mail communication is the next best choice. However, before you begin the project, make sure that both of you are committed to following through with the instructional activities planned. Agree on a tentative schedule for each portion of the project, one that accounts for the reality of the school year. Use some of the activities presented here (or your own ideas) to begin, then expand the scope of the project later.

Once you have identified an appropriate site and an interested teacher, determine the type of activities in which your students will engage. Obviously, the nature of the activity should match the type of learning outcomes that you want your students to achieve. You may want to promote your project with the school administration and parents by having your students create a newsletter or brochure explaining the activities and your students' reactions to them.

Interest Surveys

An interest survey represents a good first communications project activity for introducing two classes to each other. At the start of the project, have your students conduct an interest survey of "favorites" and "least favorites." When all students have completed the surveys, develop a database file containing the student responses and use it as the first file to exchange. When you receive the database from the other class, let students explore the file to "get acquainted" with the students in the other class. Ask your students to identify in which characteristics your students are similar to the other class (possibly favorite foods or movies) and in which characteristics they differ from students in the other class (possibly favorite pastimes or the activities in their daily schedules).

School-wide Surveys

After your students have completed the first interest surveys and exchanged the database files, ask students to conduct a similar survey of all the students in your school. When the surveys are completed and returned, have your class create a database file to hold that information. Next, have your students compare these data with the findings from their own class and their partner class. As an additional activity, you could instruct students to create bar charts to compare the four sets of data: the two sets of survey results from the classes and the two sets of survey results from the school populations. These charts could also be telecommunicated within spreadsheet files so that each class could prepare charts on topics of interest and both groups could share the charts.

Electronic Pen Pals

Establishing electronic pen pals is a standard first communications project activity that has merit. Have your students write letters of introduction to students from the other school. Use your students' explorations of the database files to help match them with students of similar interests. Arrange for the letters to be sent on the same day so that each student in both classes sends and receives a letter. Insure that every student receives a letter by asking for volunteers to write additional letters to cover absences or class size differences. When the letters arrive, print them out so each student has a letter to read.

Periodically, assign your students to write additional letters—perhaps at the end of the first quarter, after or before vacations, and near the end of the school year. Students who develop strong relationships with their pen pals may wish to write more frequently. However, assign all students to write letters at some infrequent interval or the activity will prove frustrating for students who write letters but receive no responses.

Price Comparisons

Assign each student in your class to gather data from the stores where their parents shop—possibly on the prices of selected items such as staple goods, gasoline, movie admission prices, and record or CD costs. Discuss any differences in the prices that your students discover. Next, have the students determine a "class average" price for each item, using a bar chart to illustrate the price ranges. Exchange these spreadsheet files with the partner school and have students build a composite chart comparing the price differences between the two locations on an item-by-item basis. Ask students to determine probable causes for price differences they discover (e.g. supply in demand, economy of scale, transportation costs, and bulk purchasing in urban centers).

Interactive Game Contests

As an academic motivation, have your students challenge students in the companion class to a contest such as the NIM game discussed earlier. After you have conducted a contest among the students in your own class, have the contest champion challenge your partner class' champion to a tournament. Using telecommunications, you can play the game interactively so that the classes at the two distant locations can be spectators at the event.

Instead of the NIM game, you might arrange a "college bowl" quiz game format in which each class creates questions beforehand on agreed-upon categories (emphasizing curricular topics). These questions are then randomly presented to students from the two classes. If students answer correctly, they receive a point for their class. If they miss the question, the other class has a chance to respond.

Section 5

Appendices

Appendix 1.
Off-Computer Activities—Short-Duration Answer Key

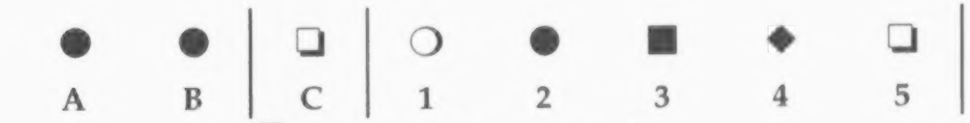
The answers provided on the following pages are offered (with some misgivings) for the sole purpose of supporting the problem-solving efforts of teachers and their students. The answers are **NOT** offered as an alternative to engaging in the problem-solving process. It is crucial to emphasize continually that the answers by themselves have no value whatsoever. The only solutions that have value in these problem situations are those explanations that have engaged the problem solvers in a process from which future and larger understandings can result.

For the most part, the following answers include a series of descriptive steps explaining one possible approach that might be followed to reach a solution. If you share these with your students, ask them to seek alternative pathways to the problem-solving steps as well as to the solutions themselves. In some cases, the suggested steps may not represent the most efficient or comprehensible process for your students to follow. Challenge your students to develop different approaches that are more understandable for them.

Occasionally, have your students submit written explanations of the steps they used to solve a particular problem (similar to the descriptions contained on the following pages). This is an excellent technique to help you understand their problem-solving processes. It can also be also very helpful to the students by helping them examine and reflect on their own thought processes.

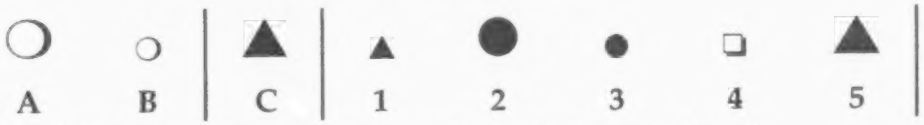
Geometric Relationships Answers

1.



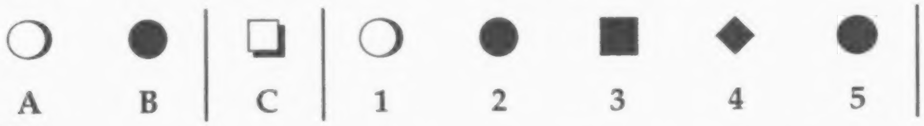
5 (❑) since A and B are identical.

2.



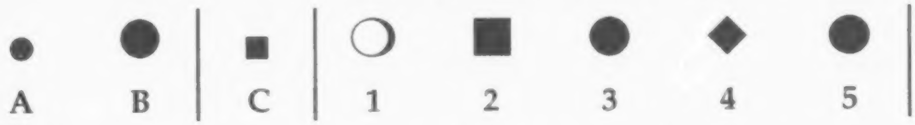
1 (▲) since B is the same shape and color but smaller than A.

3.



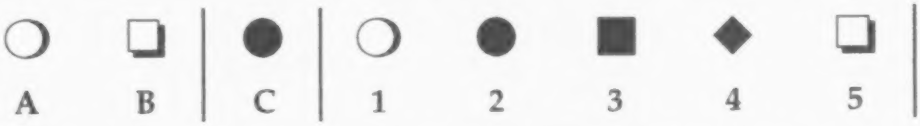
3 (■) since B is the same size and shape but a different color than A.

4.



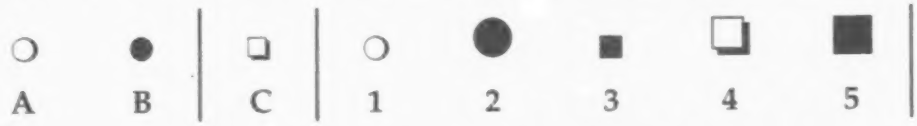
2 (■) since B is the same shape and color but a different size than A.

5.



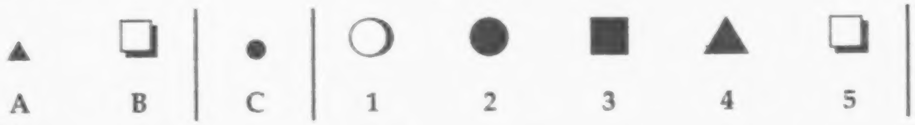
3 (■) since B is the same size and color but a different shape than A.

6.



4 (❑) since B is the same size and shape but a different color than A.

7.



5 (❑) since B is the same size but a different shape and color than A.

Analogies Answers

Compass is to direction as thermometer is to **temperature**.

> **Compass is an instrument to determine direction; a thermometer is an instrument to determine temperature.**

Likely is to improbable as miserly is to **spendthrifty**.

> **Likely is the opposite of improbable; miserly is the opposite of spendthrifty.**

A day is to nighttime as a year is to **winter**.

> **Nighttime is the end of a day; winter is the end of a year.**

Map is to driver as index is to **reader**.

> **A map is a guide to a driver; an index is a guide to a reader.**

Albany is to New York as Atlanta is to **Georgia**.

> **Albany is the capital of the state of New York; Atlanta is the capital of the state of Georgia.**

Quick is to slow as young is to **old**.

> **Quick is the opposite of slow; young is the opposite of old.**

New is to modern as old is to **ancient**.

> **New is a synonym of modern; old is a synonym of ancient.**

French is to France as **Italian** is to Italy.

> **French is the national language of France; Italian is the national language of Italy.**

Too is to two as earn is to **urn**.

> **Too is a homophone of two; earn is a homophone of urn.**

Hand is to glove as foot is to **boot**.

> **A glove is a protective covering for a hand in the winter; a boot is a protective covering for a foot in the winter.**

Ocean is to sea as **river** is to stream.

> **A sea is a smaller body of water than an ocean; a stream is a smaller body of water than a river.**

No is to know as **flew** is to **flue** (for instance).

> **No is a homophone for know; flew is a homophone for flue.**

Football is to baseball as **soccer** is to **cricket** (for instance).

> **Football and baseball are popular American sports—one relying more on the use of feet and the other relying more on the use of hands; soccer and cricket are popular English sports—one relying more on the use of feet and the other relying more on the use of hands.**

Teacher is to student as **parent** is to **child** (for instance).

> **Teachers serve to guide their students' development; parent serve to guide their children's development.**

Word Depictions Answers

Word Depictions I

Highchair
Top Notch
Side Saddle
Low Tide
High Prices
Up-hill

Word Depictions II

Downstream
Cross Roads
Upsidedown Cake
Big Deal
Inside Out
Backward Glance

Word Depictions III

Ringworm
Once Upon a Time
Long Underwear
Man Overboard
Sleeping on the Job
Head Over Heels

Word Depictions IV

Time After Time
Lazy Afternoon
The Day After Tomorrow
Age Before Beauty
Work Before Pleasure
The Day Before Yesterday

Word Depictions V

Just Between You and Me
Going Overseas
Broken Engagement
Neon Light
Love At First Sight
Misunderstanding Between Friends

Word Depictions VI

Reading Between the Lines
Safety in Numbers
Dark Circles Below the Eyes
Three Degrees Below Zero
Mixed-up Kid
The Plot Thickens

Mini-Word Chains Answers

1. Stop	Watch	Dog
2. Skeleton	Key	Hole
3. Butter	Fly	Paper
4. Hand	Bag	Pipe
5. Bird	Bath	Robe
6. Light	House	Boat
7. Note	Book	Worm
8. Horse	Shoe	Horn
9. Day	Break	Loose
10. Buffalo	Bill	Collector

Hink Pinks Answers

Hink Pinks

1. Crimson Toolhouse	**Red Shed**
2. Reading Corner	**Book Nook**
3. Class Edict	**School Rule**
4. Tidy Chair	**Neat Seat**
5. Washes Levis	**Cleans Jeans**

Hinky Pinkies

1. Pleasant Chap	**Mellow Fellow**
2. Scary Flashes	**Frightening Lightning**
3. Television Saga	**Cable Fable**
4. Urban Regret	**City Pity**
5. 1st day of School	**Summer Bummer**

Hinkity Pinkities

1. Suspense Chronology	**Mystery History**
2. Elk Melon	**Antelope Cantaloupe**
3. Dr. Lechter	**Hannibel Cannibal**

Hinkiditty Pinkiditties

1. Dutchman's Winecellar	**Knickerbocker's Liquor Locker**

Complete The Pattern Answers

1 2 3 4 5 6 7

Counting Numbers—Add 1 to the proceeding number.

2 4 6 8 10 12 14

Even Numbers—Add 2 to the proceeding number.

1 3 5 7 9 11 13

Odd Numbers—Add 2 to the proceeding number.

4 8 12 16 20 24 28

Multiples of 4—Multiply 4 by the counting numbers (1, 2, 3...).

10 20 30 40 50 60 70

Multiples of 10—Multiply 10 by the counting numbers (1, 2, 3...).

100 50 25 12.5 6.25 3.125 1.5625

Halvings of 100—Repeatedly divide 100 by 2.

3 9 27 81 243 729 2187

Powers of 3—Multiply 3 by itself once, twice, thrice, ...

1 4 9 16 25 36 49

Perfect Squares—Multiply a number by itself from 1, 2, 3...

1 8 27 64 125 216 343

Perfect Cubes—Multiply a number's square by itself from 1, 2, 3...

Assorted Puzzlers Answers

Watch Your Assumptions

The first two mathematical statements contain errors:

1. **2 divided by 2 = 1 not 4**
2. **4 divided by $^{1}/_{2}$ = 8 not 2**

The third error is the opening assertion that there are 3 errors.

What's My Number? #1

1. It is a three digit number	*The range is 100 to 999.*
2. It is less than 200	*The range is 100 to 199.*
3. It is divisible by 12 and 9	*Only 108, 144, 180 are left.*
4. It is not a square number	*This eliminate s144.*
5. Its tens digit > its units digit	*Only 180.*

The number is 180.

What's My Number? #2

1. It is a four digit number	*The range is 1,000 to 9,999.*
2. All of its digits are odd	*Determines all digits odd.*
3. All of its digits are different	*The range is 1,357 to 9,753.*
4. Thousands digit is smallest counting number	*The range is 1,357 to 1,975.*
5. It is less than 40 times 40	*The range is 1,357 to 1,579.*
6. Tens digit is < units or hundreds digits	*The range is 1,537 to 1,957.*
7. 1st + last digits = sum of middle digits	*Only 1,537 is left.*

The number is 1,537.

Boomerang

Throw the ball straight up in the air and wait for gravity to solve the problem for you.

Sock Confusion #1

If you take out three socks, they must be either be all three the same color or two of one color and one of the other. Either way, you will have a pair of black or white.

Sock Confusion #2

To guarantee a pair of white socks, you must take 12 socks. Although it is unlikely, the first 10 you select might all be black.

The Rise and Fall of the Rope Ladder

None of the rope ladder's rungs will be under water at high tide. The fishing boat (and the rope ladder) will rise with the tide since boats float in water.

This Problem is Not a Yolk

One possibility is to hold the egg four feet over the cement floor and let it go. It will travel the required three feet without breaking its shell—soon after, however, it will break.

Centennial Digits

One likely solution is **$99\frac{9}{9}$**.

The Amoebae Jar

One minute earlier.

A Hefty Problem

Meat (and probably fish and poultry as well).

Sequential Digits

The four numbers are 17, 19, 21, and 23. One approach to discover them is to find the average of 80 (i.e. 20) and use that as the median with two of the odd numbers being less than 20 and other two greater than 20.

Jug Puzzler #1

1. Fill the 3 liter jug and empty it into the 8 liter jug (3 liters of water are now in the 8 liter jug).
2. Fill the 3 liter jug a second time and again empty it into the 8 liter jug (6 liters of water are now in the 8 liter jug).
3. Fill the 3 liter jug a third time and pour as much as possible (2 liters) into the 8 liter jug (the 8 liter jug is now full and the 3 liter jug still has 1 liter of water in it).
4. Empty the 8 liter jug and then pour the 1 liter of water from the 8 liter jug into it (the 8 liter jug now has 1 liter of water in it and the 3 liter jug is empty).
5. Fill the 3 liter jug a 4th time and empty it into the 8 liter jug (the 8 liter jug now holds 4 liters of water—Shazam!).

Jug Puzzler #2

This isn't possible—two even numbers can't produce an odd difference.

Mystery Numbers #1

1. The only even prime number is 2.
2. 1 is the only counting number that isn't prime nor composite.
3. 0 is the whole number that isn't a factor of any counting number.
4. A two-digit prime > 20, the product of whose digits < 5 and whose digits sum is divisible by 4 = 31.
5. An odd, two-digit composite number < 20 = 15.
6. A three-digit, perfect cube that is a palindrome = 121.
7. Other than 1, the smallest number that's both a perfect square and a perfect cube = 64.
8. A three-digit odd number (>144), divisible by 5 whose digits' sum is a perfect square and digits' product is 15 = 315.
9. A three-digit odd number with the same units and tens digits that is the sum of three different odd perfect cubes = 855 which is $9^3 + 5^3 + 1^3$.
10. An even multiple of 5 that's a factor of 50, one > a perfect square and two > a perfect cube = 10.

Riddles

1. A farmer had 17 sheep. However, all but nine died. How many sheep does the farmer have left?

   He has the nine that didn't die left.

2. How much dirt can you remove from a hole that is 3 feet deep, 2 feet wide, and 10 feet long?

   None; that's why it's a hole.

3. Take two apples from three apples & what do you have?

   You have the two apples that you took.

4. I have two coins that total 75 cents. One of the coins is not a quarter. What are the two coins?

   A quarter and a half dollar (the half dollar is the one that is not a quarter).

5. What is the smallest number of birds that could fly in this formation: two birds in front of a bird, two birds behind a bird, and a bird between two birds?

   Three birds flying in single file.

6. Two people were playing chess. They played five games & each won the same # of games, but there were no draws. How is this possible?

   They were not playing chess against each other.

7. You are the pilot of an airplane that flies the 1,000 miles from Chicago to New York at 250 miles per hour. The plane makes one stop for thirty minutes in Cleveland. What's the pilot's name?

   Your name, since you're the pilot.

8. Which is correct: "8 and 8 are 15" or "8 and 8 is 15?"

   Neither; 8 + 8 = 16.

9. If you had a match and entered a room in which there were a kerosene lamp, an oil heater, and a woodburning stove, which item would you light first?

    Hopefully, the match.

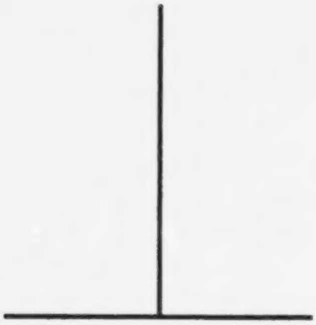
10. An archaeologist claims he found a gold coin that was dated 45 B. C. Do you believe him? Why or why not?

    Nope; B. C. was not used before the birth of Christ.

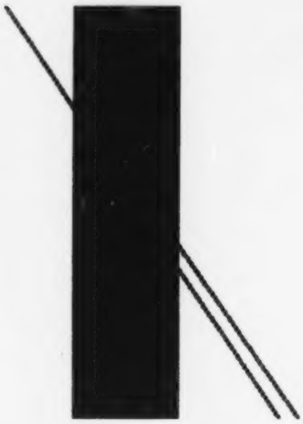
11. How can you make the odd number 7 even?

    Remove the S (from SEVEN) and it becomes EVEN.

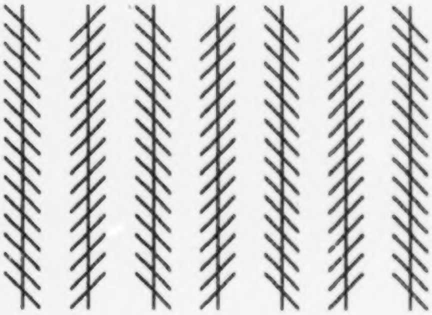
Grand Delusions I Answers



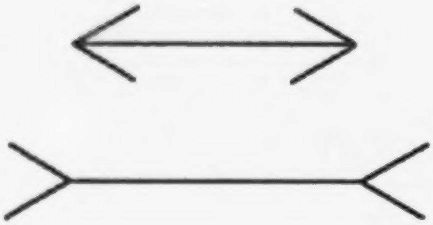
Both lines are same length



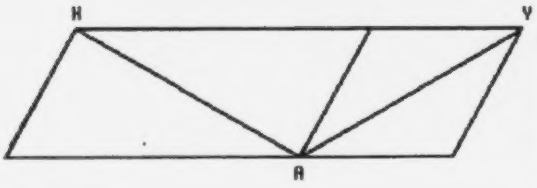
Three diagonal lines are same length



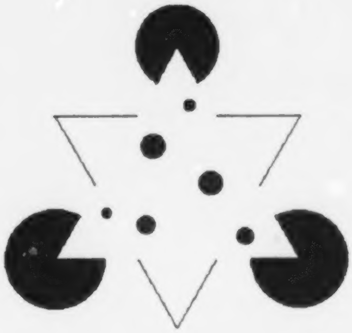
Zöllner's illusion—the vertical lines are all parallel



Horizontal lines are the same length

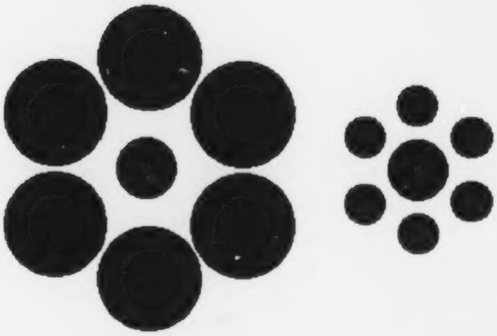


Diagonal illusion—AX = AY

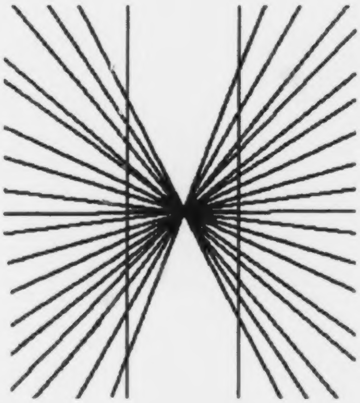


Subjective contour illusion—the white triangle with the spots isn't drawn

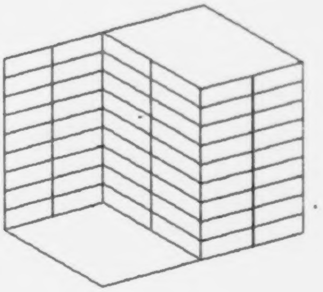
Grand Delusions II Answers



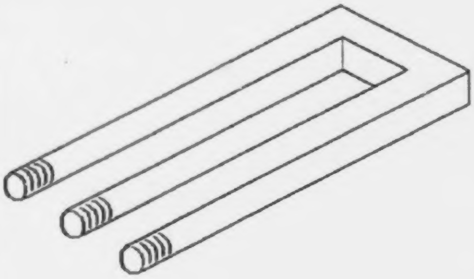
Tichener illusion—the two inner circles are the same size



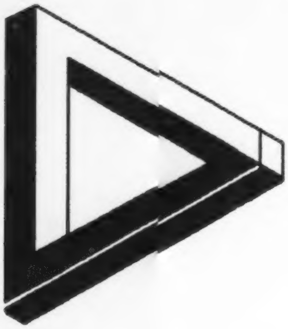
Vertical lines are straight



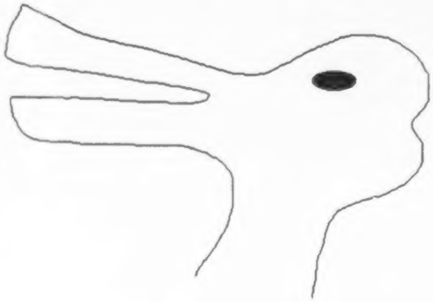
Thiery's Figure—it oscillates



Impossible figure



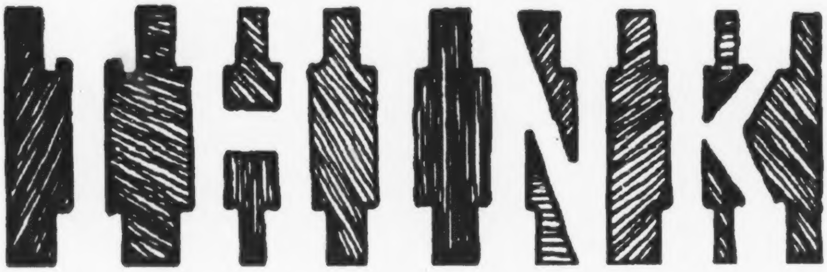
What is it?



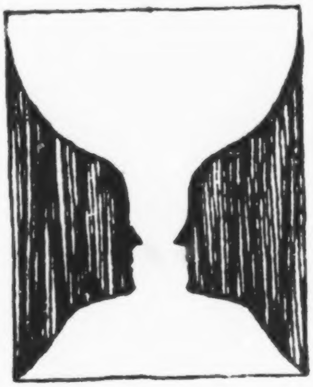
Rabbit or duck?

201

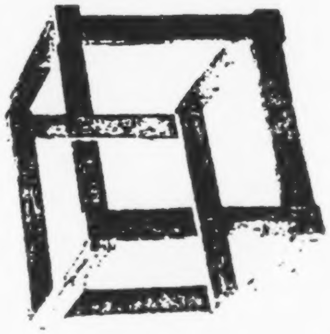
Grand Delusions III Answers



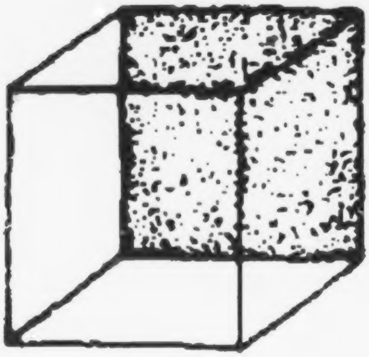
Do you see THINK or jigsaw pieces first?



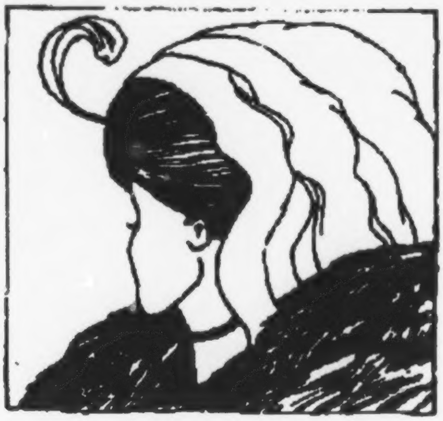
Do you see faces or wine glass?



Can you build one like it?



Is the shaded side inside or out?



Find both old & young woman

Appendix 2. Off-Computer Activities— Middle-Duration Answer Key

Moving Matches Answers

1. Move one match to form a true equation.

   IX + V = III becomes IX - VI = III

   By moving one match from the addition sign and placing it after the V to produce VI. The new equation will then read: 9 - 6 = 3.

2. Move one match to form a true equation.

   I - III = II becomes I = III - II

   By moving one match from the equal sign and placing it over the subtraction sign to produce an equal sign. The new equation will then read: 1 = 3 - 2.

3. Move two matches to form a true equation.

   X + V + I = I becomes XI - V - I = V

   By moving one match from each subtraction sign, placing one of them to the right of the X to produce XI, and putting the other to the right of the equal sign to create a V with the other I that is already there. The new equation will then read: 11 -5 -1 = 5.

4. Move one match to form a true equation.

   IV = IV - I becomes V = IV + I

   By moving one match from the left of the V and placing it across the subtraction sign to produce an addition sign. The new equation will then read: 1 = 3 - 2.

5. Make 2 triangles using 5 matches.

   I I I I I

   (Create them so that they share one side.)

6. Make 4 triangles using 6 matches.

   I I I I I I

   (Create a 3 dimensional triangular pyramid.)

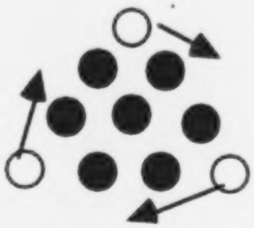
7. Make this a true equation without touching anything

   XI + I = X

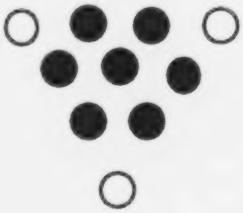
   (Walk around & look at it or stand on your head.)

More Puzzlers Answers

Pyramid Inversion



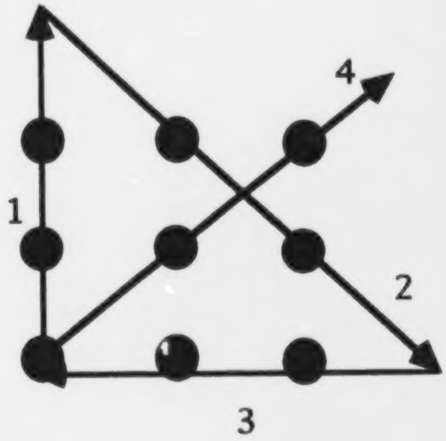
To achieve the pattern shown below, move the three hollow objects (○) illustrated above to the locations indicated with the arrows . Move the three "outer-most" dots, and leave the seven in the middle in their original positions.



Connect the Dots

The key concept here is that you must extend beyond the confines of the array to connect the nine dots with only four lines.

1. The first line should extend far enough up to allow a second line to connect the middle dot in the top line with the far right dot on the second line.
2. Draw the second line to connect the middle dot in the top line with the far right dot on the second line, then continue it until it reaches the bottom line.
3. Draw the third line through the three dots on the bottom line.
4. Draw the fourth line diagonally from the left dot on the bottom line through the middle dot of the middle line and the right dot on the top line.



The first line could start at any of the corner dots, producing a similar triangular shape, but a different orientation.

Keep Your Balance I

First Weighing—Put six balls on each side of the scale

●●●●●●   ●●●●●●

Possible Results

1. The twelve balls balance, meaning the one not weighed is the odd ball.
2. The twelve balls don't balance, meaning the odd ball is one of the six on the heavier side of the scale. Eliminate the one not weighed and the six balls on the lighter side.

Second Weighing—Put three balls on each side of the scale

●●●   ●●●

Certain Result

1. The two sides don't balance, meaning the odd ball is one of the three on the heavier side of the scale. Eliminate the three balls on the lighter side.

Third Weighing—Put one ball on each side of the scale

●   ●

Possible Results

1. The two balls balance, meaning the one not weighed is the odd ball.
2. The two balls don't balance, meaning the odd ball is on the heavier side of the scale.

Keep Your Balance II

First Weighing—Put 12 balls on each side of the scale

●●●●●●●●●●●● ●●●●●●●●●●●●

Possible Results

1. The twenty-four balls balance, meaning the one not weighed is the odd ball.
2. The twenty-four balls don't balance, meaning the odd ball is one of the twelve on the heavier side of the scale. Eliminate the one not weighed and the twelve balls on the lighter side.

Second Weighing—Put six balls on each side of the scale

●●●●●● ●●●●●●

Certain Result

1. The two sides don't balance, meaning the odd ball is one of the six on the heavier side of the scale. Eliminate the six balls on the lighter side.

Third Weighing—Put three balls on each side of the scale

●●● ●●●

Certain Result

1. The two sides don't balance, meaning the odd ball is one of the three on the heavier side of the scale. Eliminate the three balls on the lighter side.

Fourth Weighing—Put one ball on each side of the scale

● ●

Possible Results

1. The two balls balance, meaning the one not weighed is the odd ball.
2. The two balls don't balance, meaning the odd ball is on the heavier side of the scale.

The Hi School Student Dilemma Answers

STUDENT	POSITION
Ann	**Student President**
Barbara	**Cheerleader**
Carol	**Captain of the Girls' Basketball Team**

1. Since the Majorette looked for the President and the President had already left with Barbara, but Barbara can't be the President or Majorette, she is Cheerleader.
2. The President is older than the Majorette—not a necessary clue.
3. Ann is older than Barbara—not a necessary clue.
4. Since Carol had never met President, she can't be President and so must be Majorette. That means that Ann must be the President.

Diverse Mysteries I Answers

1. The number is 0.
2. The original number is 32.
3. Any number formed with 1, 2, 3, 4, 5, 6, 7, 8, 9 is divisible by 1 (of course), 3, and 9.
4. The digits to replace the letters Z, A, and P are:

   Z = 3

   A = 9

   P = 6
5. The digits to replace the letters Y and Z are:

   Y = 5

   Z = 1
6. One true equation is:

   98 - 7 - 6 + 5 + 4 + 3 + 2 + 1 + 0 = 100
7. Can you replace the letters A, B, C, D, and E to make this a true equation?

   A = 2

   B = 1

   C = 9

   D = 7

   E = 8

$$\begin{array}{r} 21978 \\ \underline{\times \quad 4} \\ 87912 \end{array}$$

Diverse Mysteries II Answers

1. The first boy gets $1.20
The second boy gets $2.00
The third boy gets $2.80

Add the 3 portions together (3 + 5 + 7 = 15) and divide the $6 by that answer. The result (40) is the number of "shares" each boy will receive at his rate, so multiply: 3 x 40 = 120, 5 x 40 = 200, and 7 x 40 = 280.

2. The 4 consecutive odd numbers are 27, 29, 31, 33.

3. The digits to replace the letters Z, Y, and A are:

Z = 9
Y= 1
A = 0

$$\begin{array}{r} \mathbf{999} \\ \underline{+\ \ \mathbf{1}} \\ \mathbf{1{,}000} \end{array}$$

4. The digits to replace the letters A, B, and C are:

A = 5
B= 1
C = 0

$$\begin{array}{r} \mathbf{55} \\ \underline{+\ \mathbf{55}} \\ \mathbf{110} \end{array}$$

5. The digits to replace the letters A, H, and E are:

H = 3
A = 1
E = 9

$$\begin{array}{r} \mathbf{31} \\ \mathbf{31} \\ \underline{+\ \mathbf{31}} \\ \mathbf{93} \end{array}$$

6. One true equation is:

123 - 45 - 67 + 89 + 0 = 100

Diverse Mysteries III Answers

1. The fewest number of balls that Ann and Sarah will need to use to produce a score of exactly 34 points is 6:

   Two balls worth 9 points = 18

   Two balls worth 6 points = 12

   Two balls worth 2 points = 4

2. The digits to replace the letters T, O, Y, J, R, I, and P to make a true equation are:

   T = 1

   R = 0

   O = 3

   I = 7

   Y = 6

   P = 2

   J = 9

$$\begin{array}{r} 136 \\ +\ \ 936 \\ \hline 1072 \end{array}$$

3. Nope; there are no three even numbers (consecutive or not) that will ever add up to any odd number {EVEN + EVEN + EVEN = EVEN}

The Narrow Bridge: What's a Farmer To Do? Answers

The first step in this problem is to identify the Duck as the "weakest link" in the problem. The Duck cannot safely be left with either of the other items. Clearly, the Duck is the first thing that must be transported, protected, and safe-guarded. Therefore:

1. Take the Duck across and leave the Wolf and the Corn behind, for the moment.
2. Take the Wolf (or the Corn; it doesn't matter which one) across and leave the Corn (or the Wolf if you choose to take the Corn next) by itself, for the moment.
3. Take the Duck back across to the original side, leaving the Wolf (or Corn) where the Duck was, for the moment.
4. Take the Corn (or the Wolf—whichever you didn't take the last time) across, and leave the Duck by itself, for the moment.
5. Take the Duck back across and proceed on your way.

Still More Puzzlers Answers

Puzzlers #3

1. There are 63 eggs in the basket.

   Fewer than 72 eggs in the basket.

   Counted by 2, one is left—it's an odd number.

   Counted by 3, none is left—it's an odd multiple of 3 or:

   3, 9, 15, 21, 27, 33, 39, 45, 51, 57, 63, 69

   Counted by 4, three are left—it's only 3, 15, 27, 39, 51, 63

   Counted by 5, three are left—it's only 3 or 63.

   Counted by 6, three are left—it's only 63.

2. One obvious way to pair the digits is:

   0+ 9 = 9   1 + 8 = 9   2 + 7 = 9   3 + 6 = 9   4 + 5 = 9

3. Use the digit 9 three times to produce a result of 11.

   99 ÷ 9 = 11

4. Use the digit 9 five times to produce a result of 10.

   $99 \div 9 - {}^{9}/_{9} = 10$

5. Use the digit 6 four times to produce a result of 42.

   $(6 + {}^{6}/_{6}) \times 6 = 42$

6. Use the digit 5 four times to produce a result of 25.

   $(5 \text{ x } 5) \div {}^{5}/_{5} = 25$

7. Use the digit 3 five times to produce a result of 31.

   $3^3 + 3 + {}^{3}/_{3} = 31$

8. The number is 54.

   Two-digit even number divisible by 9—it's only 18, 36, 54, 72, 90

   Sum of its digits is a perfect square—it's still only 18, 36, 54, 72, 90

   Number is less than 64—it's only 18, 36, 54.

   Product of its digits is 20—it's only 54.

9. The number is 288.

   3 digit even number less than 400—its range is 100 to 398.

   Its units and tens digits are the same:

   100, 122, 144, 166, 188, 200, 222, 244, 266, 288, 300, 322, 344, 366, 388

   It's the product of 3 even perfect squares: $2^3 = 8$, $4^3 = 64$, $6^3 = 216$

   Number is $8 + 64 + 216 = 288$.

10. The number is 105.

    Odd multiple of 7 that's a factor of 210—only 7, 21, 35, 105.

    It's 5 greater than a perfect square: only 21, 105.

    It's 20 less than a perfect cube: only 105.

    Number is 105.

Digit Dilemma

This is one way that the digits 1—9 can be arranged in an equation to equal 99, 999:

$$\begin{array}{r} 98,765 \\ +\quad 1,234 \\ \hline 100,000 \end{array}$$

Alphabetical Mathematics #1

Substitute digits for the letters A and M to make this equation correct.

$$\begin{array}{r} \mathrm{MA} \\ +\quad \mathrm{A} \\ \hline \mathrm{AM} \end{array} \qquad \mathrm{M} = 8 \qquad \mathrm{A} = 9$$

1. Since A + A = M and M + nothing = A + A must produce a sum greater than 10, requiring a regrouping ("carrying") of one to the tens column.
2. Therefore, A must be 5 or greater (otherwise, there would be no regrouping) and A must also be one greater than M (since M + the regrouped one = A).
3. Trial and error shows that 45, 56, 67, and 78 won't satisfy the equation, leaving only 89 to work.

Alphabetical Mathematics #2

Replace the letters O, N, E, T, and W with digits to make this equation correct.

ONE **O = 2 (or 4)**
+ ONE **T = 4 (or 8)** **N = 3**
TWO **E = 1 (or 2)** **W = 6**

1. Since E + E = O, the digit O represents must be even (since Even + Even = Even and Odd + Odd = Even). Since O + O = T, O must be either 2 or 4 (otherwise there would have been a 2 digit sum).
2. First, let's assume that O is 2 and see if we can find the other digits. E = 1 since E + E = O and T = 4 since O + O = T. W must be Even (since there is no regrouping from the units column) and can only be 6 or 8 (since 2 and 4 are taken). W can only be 6 and N can only be 3 (since T already = 4). This solution is correct but not unique.
3. Next, let's assume that O is 4 and see if we can find a second correct solution. E = 2 since E + E = O and T = 8 since O + O = T. W is still Even and can only be 6 (since 2, 4, and 8 are taken). Therefore, N = can only be 3. This scenario is also correct, but again, it isn't a unique solution.

Figure It Out #1

Produce a result of 3 using the digit 3 three times: 3 x 3 ÷ 3 = 3

Figure It Out #2

The number equal to three times the sum of its digits is 27.

Figure It Out #3

The 4 consecutive numbers that add up to 94 are: 22, 23, 24, 25.

Digital Arrangements

1. The digit 5 four times to produce 25 = $(5 \times 5) \div {}^{5}/_{5}$
2. The digit 7 three times to produce 56 = $(7 \times 7) + 7$
3. The digit 9 three times to produce 11 = ${}^{99}/_{9}$
4. The digit 7 four times to produce 56 = $(7 + {}^{7}/_{7}) \times 7$
5. The digit 6 four times to produce 42 = $(6 + {}^{6}/_{6}) \times 6$
6. Express 10 using only the digit 8 two times = 8_8
7. The digit 3 five times to produce 31 = $3^3 + 3 + {}^{3}/_{3}$
8. The digit 4 seven times to make 100 = $44 + 44 + 4 + 4 + 4$
9. The digit 9 five times to produce 10 = $9\ {}^{99}/_{99}$
10. A result of 12 with 3 of same digit (not 4 or 1) = $3 \times 3 + 3$
11. The digit 8 eight times to produce 0 = $8888 - 8888$
12. The digit 5 four times to produce 56 = $55 + {}^{5}/_{5}$
13. The digit 9 nine times to produce 1,000 = $999\ {}^{999}/_{999}$
14. The same digit 3 times to produce 30 = $33 - 3$ or $5 \times 5 + 5$
15. The number 10 ten times to produce 1 =
    $(10 + 10 + 10 + 10 + 10) \div (10 + 10 + 10 + 10 + 10)$

Appendix 3.
Off-Computer Activities—
Long-Duration Answer Key

Who are the Basketball Champs? Answer Guide

Here are the steps needed to discover the Basketball Champs for the three years.

1990

Celtics won the first game since they never lost to the Lakers.

Bulls won their game since the Knicks lost every game.

Bulls are Champs for 1990 since they never lost to the Celtics.

1991

Lakers won the first game since the Knicks lost every game.

Bulls won their game since they never lost to the Celtics.

Lakers are Champs for 1991 since a different team won the Championship each year.

1992

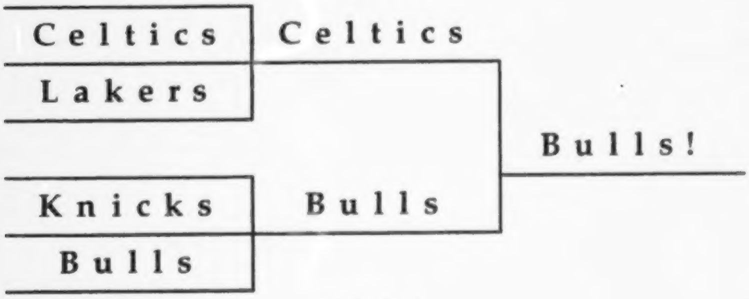
Lakers won the first game since the Bulls never lost to the Celtics, the Knicks lost every game, and a different team was the Champion each year (it must be the Celtics' year).

Celtics won their game since the Knicks lost every game.

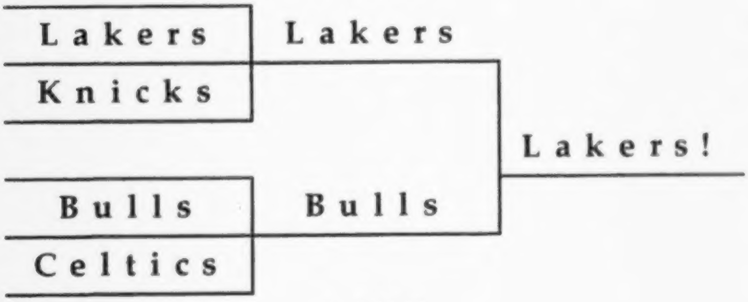
Celtics are Champs for 1992 since they never lost to the Lakers (and since a different team won the Championship each year).

Who are the Basketball Champs? Answers

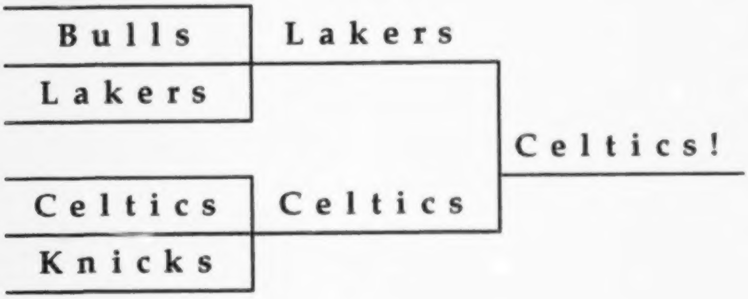
1990


Celtics
Lakers
Knicks
Bulls
Celtics
Bulls
Bulls!

1991


Lakers
Knicks
Bulls
Celtics
Lakers
Bulls
Lakers!

1992


Bulls
Lakers
Celtics
Knicks
Lakers
Celtics
Celtics!

Death-Star Rock Group Answers

NAME	BASS	DRUMS	GUITAR	HORN
Brad	X	O	X	X
Dan	X	X	X	O
Gus	O	X	X	X
Hank	X	X	O	X

1. No one plays an instrument starting with same letter as his first name: Brad doesn't play Bass, Dan doesn't Drum, Gus doesn't play Guitar, & Hank doesn't play Horn.
2. Since Brad doesn't like the Horn player, he doesn't play Horn.
3. Since Hank's best friend is the drummer, he doesn't play Drums.
4. Gus is the Bass player, so no one else plays the Bass.
5. Since Hank doesn't play Horn (1), Drums (3), or Bass (4), he must play Guitar.
6. Since Brad doesn't play Bass (1), Horn (2), or Guitar (5), he must play Drums.
7. Dan must play Horn since it's all that is left.

Brad plays Drums	**Dan plays Horn**
Gus plays Bass	**Hank plays Guitar**

Business Disorder Memory Chart Answers

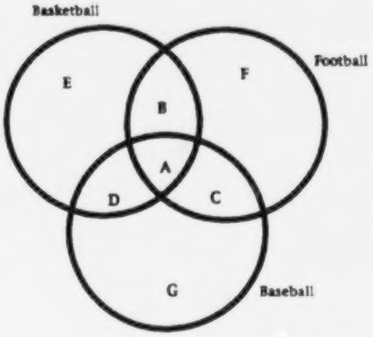
	Assistant Manager	Manager	Cashier	Secretary	Clerk	Teller
Mr. Brown	O	X	X	X	X	X
Mr. Case	X	X	O	X	X	X
Miss Grant	X	X	X	O	X	X
Mrs. Jen	X	O	X	X	X	X
Miss Lint	X	X	X	X	O	X
Mr. O'Shea	X	X	X	O	X	X

Business Disorder Explanation

1. Mrs. Jen must be the Manager since: the Manager is married with a grandson (1) eliminating Miss G and Miss L; Mr. B since he's a bachelor (4); and Mr. C who is too young for grandchildren (5); finally, Mr. O since he's the neighbor (5). Mrs. J is the only one left.
2. Miss Lint is Teller since: Manager is Mrs. J, the Teller is female & Miss G's step-sister (3), eliminating Mr. B, Mr. C, Mr. O and Miss G. Miss L is the only one left.
3. Mr. O'Shea is Secretary since: the Manager is Mrs. J, Teller is Miss L, Secretary is married (2), eliminating Miss G, Mr. B (4), and Mr. C is too young to have a married daughter (5). Mr. O is the only one left.
4. Miss Grant is Clerk since: Manager is Mrs. J, Teller is Miss L, Secretary is Mr. O, Assistant Manager (1) and Cashier (2) are male, meaning Clerk is the only position left for Miss G.
5. Mr. Case is Cashier since: Mr. B and Mr. C are the only ones left, Cashier is married (2) and Mr. B is a bachelor (4). Mr. C must be Cashier.
6. Mr. Brown is Assistant Manager since he is the only employee left and it is the only position left.

Sporting Sorting Answers

1. Begin with the eight players who are on all three teams—put them in Section A.
2. Of the 12 students who play football and basketball, eight are in Section A because they also play baseball—put the remaining four (12 - 8) in Section B.
3. Of the 15 students who play both baseball and football, 8eight are in Section A because they also play baseball—put the remaining seven (15 - 8) in Section C.
4. Of the 14 students who play both baseball and basketball, eight are in Section A because they also play baseball—put the remaining six (14 - 8) in Section D.
5. There are a total of 21 players on the basketball team. Since Sections A, B, and D total 18 (they play basketball and other sports)—put the remaining three (21 - 18) in Section E.
6. There are a total of 29 players on the football team. Since Sections A, B, and C total 19 (they play football and other sports)—put the remaining 10 (29 - 19) in Section F.
7. There are a total of 26 players on the baseball team. Since Sections A, C, and D total 21 (they play baseball and other sports)—put the remaining five (26 - 21) in Section G.
8. Add all of the figures in the various sections for a Total of 43 players.



Geometric Decoder Answers

❍ + ❍ = ● *(see below, use clues together)*

❍ x ❍ = ❍ *(means ❍ = 1 and ● = 2 since 1+1= 2 and 1x1= 1)*

❍ + ● = ▼ *(means ▼ = 3 since ❍ = 1, ● = 2 and 1+ 2 = 3)*

▼ + ▼ + ▼ = ♥ *(means ♥ = 9 since ▼ = 3 and 3 + 3 + 3 = 9)*

● + ▼ = ❑ *(means ❑ = 5 since ● = 2, ▼ = 3, and 2+ 3 = 5)*

♥ x ■ = ■ *(means ■ = 0 since ♥ = 9 and 9 x 0 = 0)*

Now, only 4, 6, 7, 8 are left as possibilities, and 3 plus one of the digits equals another one in the equation below. The only possible combination of the digits is 3 + 4 = 7. Therefore:

▼ + ▲ = ◆ *(means ◆ = 7 since ▼ = 3 and ▲ = 4)*

▲ + ▲ = ☆ *(means ☆ = 8 since ▲ = 4 and 4 + 4 = 8)*

(The digits and the shapes they represented are listed below.)

(The digit 6 was not used.)

8	7	3	9	4	5	0	2	1
☆	◆	▼	♥	▲	❑	■	●	❍

Digital Discovery I Answers

The digits that were hidden under each card are listed below.

	Column 1	Column 2	Column 3
Row 1	0	8	3
Row 2	5	1	7
Row 3	2	4	6

Digital Discovery II Answers

The digits that were hidden under each card are listed below.

	Column 1	Column 2	Column 3
Row 1	3	1	5
Row 2	8	2	6
Row 3	9	4	7

Find My Word I Answers

1. II x II = ITI *(means only 11 or 22 possible since 3 digit product)*

2. II x II = ITI *(means only 11 possible since 22 x 22=484)*

3. II x II = ITI *(means I = 1 and T = 2 since 11 x 11=121)*

4. IT x IT = IHH *(means H= 4 since 12 x 12 =144)*

5. NT x IK = NTK *(means K= 0 since I = 1 and 10 x NT = NT0)*

6\.

$$\begin{array}{r} \text{IHH} \\ -\ \text{IC} \\ \hline \text{ICI} \end{array}$$

(means C= 3 since I = 1 and H = 4)

7. ONTC ÷ H = TIEE *(means O = 8 since T= 2, H = 4 and 2 x 4 = 8)*

8. ONTC ÷ H = TIEE *(means N= 6 since T= 2, H = 4 and N - 4 = 2)*

9. ONTC ÷ H = TIEE *(means E= 5 since H = 4, T= 2, K = 0 and E x 4 = 20)*

10. EN ÷ M = O *(means M= 8 since E= 5, N= 6, O = 8 and 56 ÷ M = 8)*

11\.

$$\begin{array}{r} \text{HNKO} \\ +\ \text{CI} \\ \hline \text{HNCP} \end{array}$$

(means P = 9 since O = 8, I = 1 and 8 + 1 = P)

K	I	T	C	H	E	N	M	O	P
0	1	2	3	4	5	6	7	8	9

Find My Word II Answers

1. R x R = R + R	*(means R = 2 since it's the only digit that works)*
2. $\begin{array}{r} \text{PKSR} \\ +\ \text{CSR} \\ \hline \text{LOEP} \end{array}$	*(means P= 4 since R = 2 and 2 + 2 = 4)*
3. $\begin{array}{r} \text{CW} \\ +\ \text{OS} \\ \hline \text{ES} \end{array}$	*(means W= 0 since W + S = S)*
4. CP x OW = CPW	*(means O = 1 since W= 0 and CP x O = CP)*
5. $\begin{array}{r} \text{ACL} \\ -\ \text{SO} \\ \hline \text{LEP} \end{array}$	*(means L = 5 since O = 1, P = 4 and 5 - 1 = 4)*
6. $\begin{array}{r} \text{ACL} \\ -\ \text{SO} \\ \hline \text{LEP} \end{array}$	*(means A = 6 since L= 5 and A - __ = 5, must be regrouped 1)*
7. CSR – ORR = ACW	*(means C= 7 since A = 6 , O = 1 and C - 1 = 6)*
8. RO ÷ C = K	*(means K= 3 since R= 2, O = 1, C = 7, and 21 ÷ 7 = K)*
9. CW $\dot{+}$ OS = ES	*(means E= 8 since C = 7, O = 1, W = 0 and 7 + 1 = E)*
10. CSR – ORR = ACW	*(means S= 9 since R= 2, C = 7 and S - 2 = 7)*

W	O	R	K	P	L	A	C	E	S
0	1	2	3	4	5	6	7	8	9

Cooperative Chaos Answers

	DICK	HARRY	SYBIL	TOM
FIRST	Bombers	Dinos	Apes	Champs
SECOND	Champs	Apes	Dinos	Bombers
THIRD	Apes	Bombers	Champs	Dinos
FOURTH	Dinos	Champs	Bombers	Apes

1. Since all taught their favorite groups Second period: Sybil (as Team Leader) had the Dinos (clues C and E), Dick had Champs (clue D), and Tom had Bombers (clue D). Therefore, Harry had Apes Second period—only group left.
2. Third period: Dinos had Tom (clue A), Champs had Sybil (clue B), and Bombers had Harry (clue E). Therefore, Dick had Apes Third period—only group left.
3. First period: Sybil had the Apes since they were Harry's favorite group (clue A and step 1). Also, Tom had Champs (since he had Bombers & Dinos Second and Third), Harry had Dinos (since he had Apes & Bombers Second and Third), and Dick had Bombers—only group left.
4. Fourth period: Tom had the Apes since they were the one group he hadn't had. Also, Harry had Champs, Dick—Dinos, and Sybil—Bombers for same reason.

Apes Schedule

Ist Period	**Sybil**	2nd Period	**Harry**
3rd Period	**Dick**	4th Period	**Tom**

A Non-Vulcan Mind Meld Answers

A. 26 = L of the A. = **Letters of the Alphabet**

B. 7 = W. of the A. W.= **Wonders of the Ancient World**

C. 1001 = A. N.= **Arabian Nights**

D. 12 = S. of the Z.= **Signs of the Zodiac**

E. 54 = C. in a D. (with J.)= **Cards in a Deck (with Jokers)**

F. 9 = P. in the S. S.= **Planets in the Solar System**

G. 88 = P. K.= **Piano Keys**

H. 13 = S. on the A. F.= **Stripes on the American Flag**

I. 32 = D. F. at which W. F.= **Degrees at which Water Freezes**

J. 18 = H. on a G. C.= **Holes on a Golf Course**

K. 90 = D. in a R. A.= **Degrees in a Right Angle**

L. 200 = D. for P. G. in M.= **Dollars for Passing Go in Monopoly**

M. 3 = B. M. (S. H. T. R.)= **Blind Mice (See How They Run)**

N. 24 = H. in a D.= **Hours in a Day**

O. 1 = W. on a U.= **Wheels on a Unicycle**

P. 5 = D. in a Z. C.= **Digits in a Zip Code**

Q. 57 = H. V.= **Heinz Varieties**

R. 11 = P. on a F. T. = **Players on a Football Team**

S. 1,000 = W. that a P. is W= **Words that a Picture is Worth**

T. 29 = D. in F. in a L. Y.= **Days in February in a Leap Year**

U. 300 = P. in a P. G. in B.= **Pins in a Perfect Game in Bowling**

V. 40 = D. & N. of the G. F.= **Days & Nights of the Great Flood**

W. 87 = F. S. and 7 Y. A.= **Four Score and Seven Years Ago**

X. 360 = D. in a C. = **Degrees in a Circle**

Y. 1,000 = Y. in a M.= **Years in a Millennium**

Z. 6 = F. on a C.= **Faces on a Cube**

Appendix 4.
Additional Problem-Solving Supplies

This list includes additional materials that will prove useful in supporting your students' problem-solving efforts. You should acquire as many of these resources as you can and have them available for your students to use whenever a need arises.

String (various lengths)
Rubber bands
Paper money
Plastic coins
Scissors
Tape
Clay
Graph paper
Stop Watch
Geoboards
Graduated containers (metric)
Graduated containers (English)
Cuisenaire rods
Tape measure
Pens, pencils, and paper
Colored markers
Directional compass (N, S, E, W)

Manipulative objects:
Buttons
Washers
Marbles
Sticks
Bottle caps
Acorns
Cardboard squares
Tiddly Wink disks
Tongue depressors
Checkers
Paper clips
Beans
Rulers
Two pan balance
Dice (large and small)
Drawing compass (circles)

Thermometers
Calculators (with memory)
Straws
Dienes blocks
Maps
Wooden (or plastic) cubes
Solid geometric shapes
Sand
Microcomputers
Toothpicks
Napier's rods
Globes
Plane geometric shapes
Spinners

Appendix 5.
Selected Problem-Solving Software

The next several pages contain lists of the selected problem-solving computer software for which activities were presented in the section of the text devoted to on-computer problem-solving activities. There is a great deal of problem-solving software available, some better than others. The key ingredient to successful problem-solving experiences is not which computer program you use, but the manner in which you use the software. The section of the text examining on-computer problem-solving activities provides a more complete explanation of the type of pre-computer, on-computer, and post-computer activities that ensure a valuable educational experience for students.

The first two lists, Sunburst and Tom Snyder, contain names of programs that are copyrighted; they cannot legally be copied. You must purchase them individually, which usually means that you must buy one copy of the program for each computer on which you intend to use it. However, site licenses do exist for programs you intend to use in a hands-on computer lab setting. The third list contains a brief description of the public domain software included on the disk packaged with this text. All of these files are public domain, meaning that they can be freely copied for educational use by colleagues or your students.

Sunburst

Program Name/Grade Level	Problem-Solving Skills Reinforced
Animal Trackers (4 – 10)	Analyzing Data Pattern Recognition Organizing Information
The Factory (4 – Adult)	Spatial Perception Sequencing Working Backwards
How the West Was 1 + 3 x 4 (4 – Adult)	Sequencing Pattern Recognition Systematic Problem Solving
King's Rule (4 – Adult)	Sequencing Looking for Patterns Working Backwards
Muppetville (Pre-K – 1)	Pattern Recognition Attribute Recognition
Puzzle Tanks (3 – Adult)	Generating Multiple Solutions Impossible Problems Modularizing Problems
Word-A-Mation (4 – Adult)	Working Backwards Estimating, Predicting, Projecting Scanning for Clues

Tom Snyder

Program Name/Grade Level	Problem-Solving Skills Reinforced
The Mystery of the Hotel Victoria (5)	Deductive Reasoning Organizing Information Examining Assumptions Systematic Problem Approach
The Goodell Diamond Caper (6)	Deductive Reasoning Organizing Information Examining Assumptions Systematic Problem Approach
The Secret of Vincent's Museum (7)	Deductive Reasoning Organizing Information Examining Assumptions Systematic Problem Approach
The Treasure of Fisher's Cove (8)	Deductive Reasoning Organizing Information Examining Assumptions Systematic Problem Approach

Public Domain

Program Name	Problem-Solving Skills Reinforced
BAGELS	This simple game encourages a systematic approach to problem solving. With a two-digit number, the game is quite simple. With a four-digit number, it's much more complex. To use the program, type RUN BAGELS.
CRYPTO	This program provides practice in pattern recognition by generating cryptograms to solve. Students can create messages of specified content for partners to decode, or they can solve the computer's own codes. To use the program, type RUN CRYPTO.
DIVISION	This program encourages numerical pattern recognition by providing division calculations to any specified number of decimal digits. To use the program, type RUN DIVISION.
HURKLE GAME	This game encourages a systematic approach to problem solving and introduces learners to the coordinate system. To use the program, type RUN HURKLEGAME.
EQUATIONS	This program encourages a systematic approach to equation solutions by providing students with linear equations to solve. To use the program, type RUN EQUATIONS.
OTHELLO	This more complex game encourages pattern recognition and a systematic approach to problem solving. To use the program, type RUN OTHELLO.
TOWERS	This program is modeled on the Towers of Hanoi puzzle. The game encourages working backwards and abstract thinking. To use the program, type RUN TOWERS.

Appendix 6. Additional Readings

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